Compressed Air Magazine

VOLUME 47 · NUMBER 2 FEBRUARY 1942 LONDON · NEW YORK · PARIS

PHOTO BY FERENZ FEDOR

INDIAN SASH WEAVER

MORE AIR PRESSURE... Continuously
at the drill
INGERSOLL-RAND

INGERSOLL-RAND Channel Valve. Channel ... *or plate* ... valves stay clean longer when the compressor lubricant is *Texaco Alcaid, Algol or Ursa Oil.*

YOUR AIR TOOLS will stay on the job, make more footage per day, be assured of maximum air pressure *continuously* at the drill . . . when your compressors are lubricated with *Texaco Alcaid, Algol* or *Ursa Oils.*

These Texaco oils are highly stable, resist gum, sludge and carbon formation. They keep valves clean, rings free and pressures UP.

The outstanding performance that has made Texaco preferred in the fields listed in the panel has made it preferred by compressor operators everywhere.

These Texaco users enjoy many benefits that can also be yours. A Texaco Lubrication Engineer will gladly cooperate . . . just phone the nearest of more than 2300 Texaco distribution points in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York, N. Y.

THEY PREFER TEXACO

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

FOR YOUR ENJOYMENT • TWO GREAT RADIO PROGRAMS

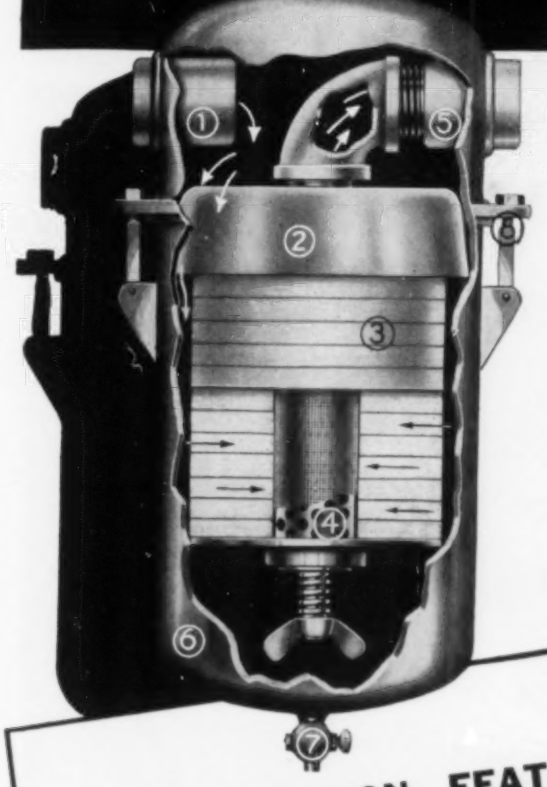
FRED ALLEN every Wednesday night. See your local newspaper for time and station.

METROPOLITAN OPERA. Complete broadcasts of great operas every Saturday. See your local newspaper for time and station.

TEXACO Lubricants
FOR ALL COMPRESSORS AND AIR TOOLS

RETURN METAL DRUMS PROMPTLY . . . thus helping to make present supply meet industry's needs and releasing metal for War Needs.

HAZARD of Oil and Moisture in Automatic Controls NOW ELIMINATED



New Filter Delivers Dry Air Only

Amazing results are being reported by users of Staynew's Model AAPHS Pipe Line Filter as a final stage in the protection of delicate pneumatic control instruments.

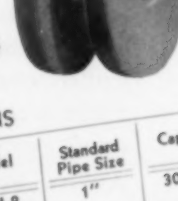
Typical comment is that of a large producer of electric and steam power who says, "We tried several well-known methods of moisture and oil elimination without satisfactory results. Your Model AAPHS was finally installed in the air line and since then we have had no trouble whatever with oil or moisture in our automatic controls."

NEW 44-PAGE CATALOG: Describes entire line, including filters for building ventilation, pipe lines, engine, and compressor intakes. Your copy is ready.

CONSTRUCTION FEATURES

(1) inlet; (2) baffle that distributes vapor-laden air to sides of container (6); (3) felt rings; (4) perforated liner; (5) outlet; (7) drain cock; (8) swing bolts for easy inspection (optional).

THICK FELT RINGS that remove every trace of oil or moisture. ➜



SPECIFICATIONS

Model	Standard Pipe Size	Capacity	Model	Standard Pipe Size	Capacity
AAPH-02 AAPHS-02	¼"	5 CFM	AAPH-2 AAPHS-2	1"	30 CFM
AAPH-01 AAPHS-01	¼"	7 CFM	AAPH-4 AAPHS-4	1½"	50 CFM
AAPH-0 AAPHS-0	½"	10 CFM	AAPH-5 AAPHS-5	2"	100 CFM
AAPH-1 AAPHS-1	¾"	20 CFM			

Letter S in code numbers indicates swing-bolt type, which facilitates inspection.

Write for Bulletin "A"

STAYNEW FILTER CORP.

7 LEIGHTON AVE., ROCHESTER, N. Y.

"Air Filter Headquarters"

PROTECTOMOTOR
99 9/10 Per Cent
AIR FILTERS

PANEL (below) for high-pressure boiler controls. Model AAPHS filter protected..

WANT YOUR DETACHABLE BITS TO LAST LONGER?
BEFORE GRINDING
AFTER GRINDING

• How long a detachable bit lasts depends on the conditions under which it operates. But your bits will last *longer* if they are properly ground with Aloxite Brand Aluminum Oxide wheels. These wheels hold their shape longer without dressing, thus assuring the accurate grinding which means greater production and longer use. Aloxite Brand wheels always cut cool, with light pressures and easy action; whereas ordinary wheels that are not cool cutting heat up your bits and draw the temper.

Each bit reground with an Aloxite Brand wheel will cut as efficiently as a new one. These wheels cut with lightning-fast speed, and the tough Aloxite Brand Aluminum Oxide grain gives each wheel exceptionally long life. You get faster grinds every time, more grinds per wheel and more work from each resharpened bit. That's *triple* economy!

Aloxite Brand Aluminum Oxide wheels come in a variety of grits and bonds to meet the requirements of every user.

CARBORUNDUM
ABRASIVE PRODUCTS

Remember the name "Aloxite Brand" when you order.

THE CARBORUNDUM COMPANY • NIAGARA FALLS, N. Y.

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

(Carborundum and Aloxite are registered trade-marks of and indicate manufacture by The Carborundum Company)

MAKE'EM Fast BUT MAKE'EM Good!

No matter what tools of war your plant is turning out, quantity *and* quality are needed Now. When these two are combined, Victory is assured.

This is the rule at SKF; and—despite production pressure—the peacetime reputation of SKF bearings is being amply sustained under the sterner demands of war.

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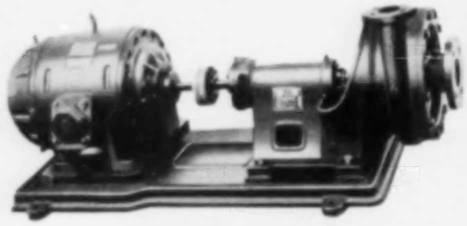
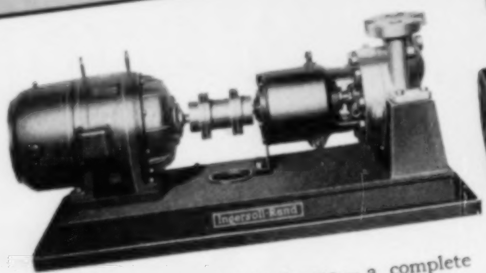
BALL BEARINGS SKF ROLLER BEARINGS

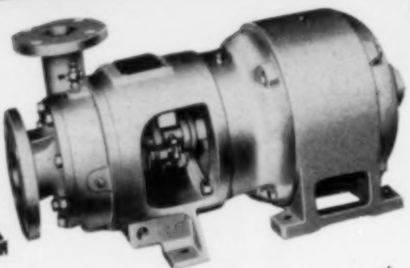
Pumping and



Cradle-Mounted Pumps — any type of driver may be used—sturdy and durable—capacities, 5 to 1500 gpm.— heads 10 to 500 ft.

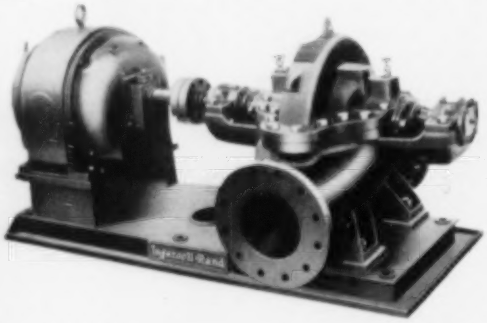


Volatile and Hot-Liquid Pumps — a complete line of single and multi-stage units—capacities, 10 to 3000 gpm.— heads to 7000 ft.—temperatures to 800°F.

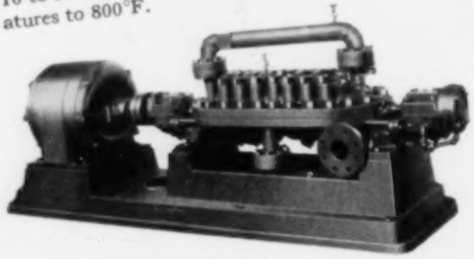


Motorpumps — efficient and compact — single and two-stage types available. Capacities, 5 to 1500 gpm.— heads to 500 ft.

Mixed-Flow Vertical Pumps — for water supply and large capacity work — capacities to 60,000 gpm.— heads to 45 ft. per stage.



Single-Stage Volute Pumps—highly efficient—suitable for many types of transfer and circulating work—capacities, 25 to 100,000 gpm. — heads 10 to 350 ft.

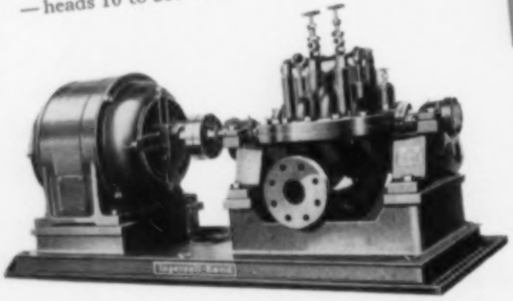


Multi-Stage Pumps—a variety of types to suit high head application — capacities, 50 to 3000 gpm.— heads to 7000 ft.

CENTRIFUGAL PUMPS For Handling Liquids

Efficient, reliable pumps for liquid transportation and circulation are a vital requirement for equipment used in most processes.

Ingersoll-Rand pumps are well known for their durability, efficiency and trouble-free operation. There is an I-R pump for every liquid handling problem. Capacities are available to 100,000 gals. per min. They may be constructed of materials for almost any liquid and for temperatures from below freezing to 800°F. A few of the many types are illustrated on this page.



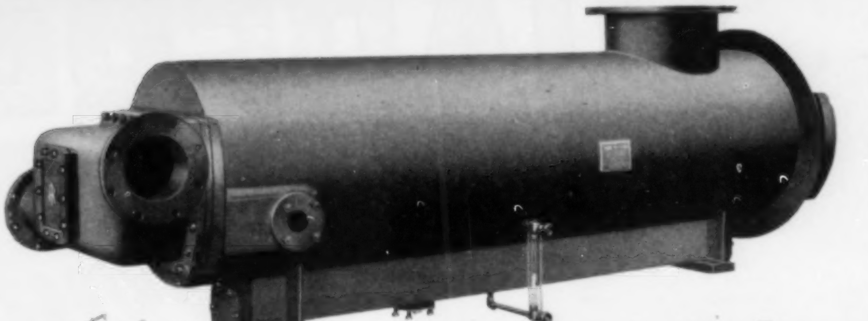
Two-Stage Pumps — for moderate head service — capacities, 50 to 3000 gpm.— heads 115 to 1050 ft.

Turbine-Driven Pumps — built-in turbine saves space—efficient and reliable—capacities, 10 to 1500 gpm.—heads 10 to 500 ft.

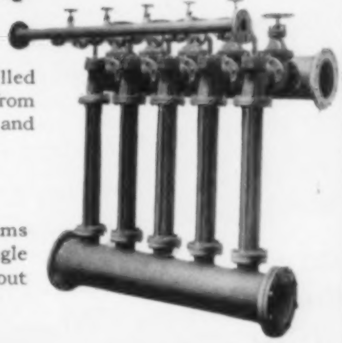
OTHER I-R PRODUCTS FOR THE PROCESS INDUSTRIES

- Aftercoolers, air and gas
- Air and Gas Compressors
- Ammonia Compressors
- Blowers and Exhausters
- Diesel and Gas Engines
- Hoists, air and electric
- Pneumatic Tools
- Receivers, air and gas
- Sump Pumps, air-operated
- Vacuum Pumps

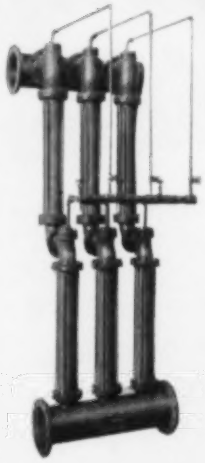
Vacuum Equipment



Surface Condenser — unexcelled performance for prime movers from 200 to 160,000 kw. capacity and process service.



Single-Stage Ejectors — for vacuums to 2" Hg. absolute—available in single or multiple elements with or without precoolers and aftercondensers.



Multi-Stage Ejectors— for vacuums to 1 mm Hg. absolute—single or multiple element with or without precoolers, intercondensers and aftercondensers.

Barometric Condenser — for vacuum service where it is not necessary to reclaim condensate. Will handle wide variations in load — can handle vapor containing chaff or solids.

CONDENSERS and STEAM JETS For Producing Vacuum

Ingersoll-Rand condensers and steam-jet ejectors are an efficient and reliable means of producing vacuum for dryers, coolers, evaporators, stills, deaerators, impregnators, deodorizers, dephlegmators, crystallizers, conditioners, sterilizers, prime movers and other vacuum equipment. I-R vacuum equipment is available in a variety of types for vacuums up to 1 mm absolute.

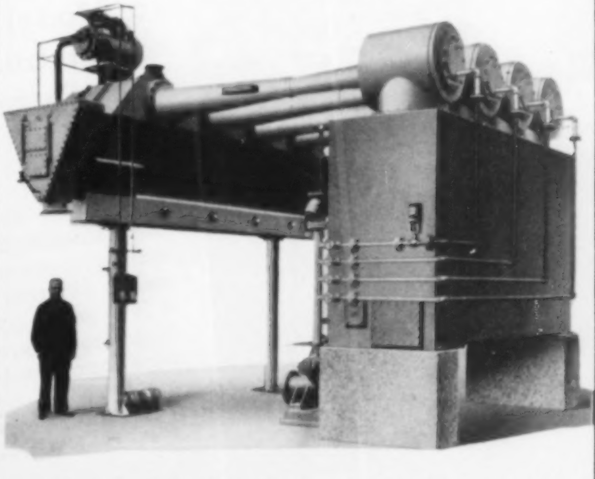
Single-stage ejector mounted on direct-contact aftercondenser.

Two-stage, twin element ejector mounted on surface type inter- and aftercondenser.

Barometric-Condenser Type Coolers — for use where vertical height and condensate recovery are not important. Ideal where capital outlay maintenance and operating costs must be low.

STEAM-JET COOLERS For Producing Cold

Where steam is available steam-jet coolers are an ideal method of producing temperatures down to 35°F. Water is the only refrigerating medium.



Surface-Condenser Type Coolers—for use where compactness is required or where condensate must be recovered.

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Let EIMCO-FINLAY LOADERS

WESTERN UNION
TELEGRAM

help solve your Production Problem

Today every mine manager is being urged to INCREASE PRODUCTION. New ore bodies must be opened up — new stopes started — more men put to work blasting down ore.

In many cases Eimco-Finlay Loaders are the best solution of the problem. When used to speed-up development work in drifts and tunnels one machine loads out the deepest possible round in less than two hours — assures a complete cycle of drilling, blasting and mucking-out in one shift.

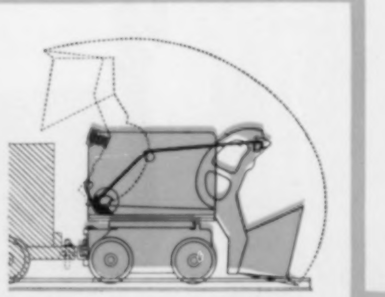
When used for loading out of stopes and raises they eliminate all of the delay and expense ordinarily required for installing bins, gates and chutes — get out the ore much more rapidly and economically. One mine recently reported loading 178 cars out of a shrinkage stope in six hours with a Model 12-B Eimco-Finlay Loader and immediately ordered another similar machine for the same type of service. Details regarding their track layout, etc., will be furnished promptly on request.

Although widely used for nearly ten years, and well-known to most mining men, the Eimco-Finlay Loader has been so constantly improved that our present models are much different and far better than those of a few years ago. Bulletin 105 (36 large fully-illustrated pages) gives complete information regarding design, construction and typical methods of application in drifts, tunnels, rooms and stopes. Write today for free copy or use the convenient coupon.

DIGGING -- in a Copper Mine

ELEVATING -- in a Lead-Zinc Mine

DUMPING -- in an Iron Mine



EIMCO PATENTS

give exclusive rights to the use of any rocker-arm profile other than a segment of a true circle and to the use of any rocker-arm which rolls on a supporting track or bed. No other known method for controlling the action of a mucking machine permits such simple sturdy construction or gives such high operating efficiency.

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I am interested in mechanical loading and would like to receive a copy of your new Bulletin No. 105 with the understanding that no charge or obligation of any kind will be incurred.

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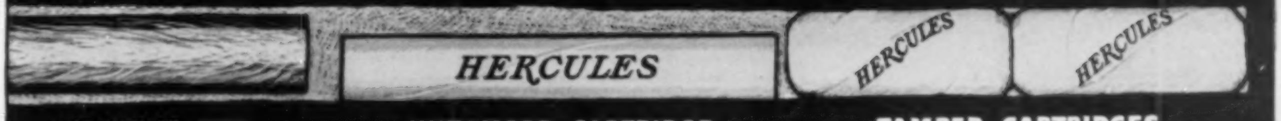
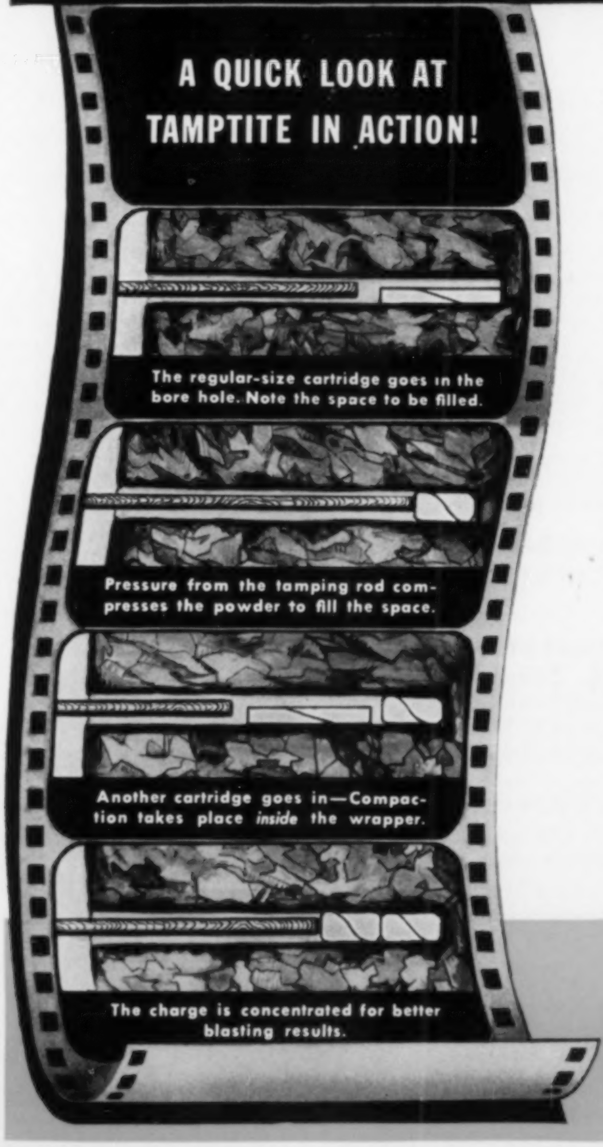
Announcing TAMPTITE

THE NEW HERCULES CARTRIDGE WRAPPING



TAMPING ROD **UNTAMPED CARTRIDGE** **TAMPED CARTRIDGES**

A QUICK LOOK AT TAMPTITE IN ACTION!



The regular-size cartridge goes in the bore hole. Note the space to be filled.

Pressure from the tamping rod compresses the powder to fill the space.

Another cartridge goes in—Compaction takes place *inside* the wrapper.

The charge is concentrated for better blasting results.

faster loading . . . better breakage . . .

Have you seen miners slit cartridges of dynamite to make them fit tightly in the bore hole? That's just one of many ways that explosives men have tried for years to lick the problem of concentrating charges for hard rock blasting.

Tamptite really does the job. This unique Hercules development lets the charge be compressed *inside* the wrapper. This means no spillage of powder in the bore hole—just the thing for loading uppers.

It's such a simple, quick way to concentrate the charge that we believe its adoption is inevitable in tunneling, metal mining; in fact, wherever good breakage of rock is needed.

HERCULES POWDER COMPANY
INCORPORATED
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A-82

NO PRIORITIES ON ENGINE WEAR!

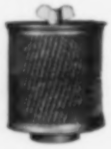
WEAR is still unrestricted..it continues regardless of material shortages. Now, more than ever before, you need the positive protection of AIR-MAZE Air Filters to make your present equipment *LAST LONGER.*

Only AIR-MAZE Air Filters have this famous AIR-MAZE Filter Element

Reduce Abrasive Wear with this

OIL BATH TYPE

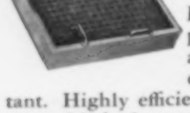
Removes more than 99% of abrasive dust and grit, with less than 1.5" H_2O pressure drop. Will not clog. Easily installed on engines, compressors, blowers, etc. Automatic oil bath action constantly cleans filter element.



An Effective Spark Arrester and Air Filter

UNIMAZE TYPE

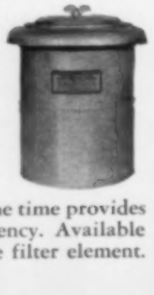
A highly efficient viscous-coated filter designed for smaller applications, such as automotive, aircraft and marine. Easily installed. Quickly cleaned. U. L. approved spark arrester. Only 1/8" H_2O restriction.



"Trap" Dust, Moisture, Paint, Oil with

PANEL TYPES

Permanent — need no replacement. Easily cleaned and recharged. All metal construction. Fire resistant. Highly efficient—99.83%. Low restriction. Made in various models for diverse applications—from air-conditioning to paint spray booths. In all reasonable sizes and shapes to fit existing frames.



Eliminate Objectionable Intake Noises with

FILTER-SILENCER TYPE

More than a silencing device "added on" to a filter. Highly efficient accoustical chamber is integral part of filter. Effectively eliminates objectionable intake noises—at same time provides 99% *plus* air filtering efficiency. Available with oil bath *or* viscous type filter element.

It's always good business to give your equipment the best of care—to get maximum service with the minimum of maintenance. TODAY, it's even more important. Your engines, compressors and blowers will have to *work harder* and *last longer* if America's "all out" program is to succeed.

Good Air Filter protection is just as essential as good lubrication in preserving your equipment at peak efficiency. Abrasive dust and grit, entering the air intakes, can quickly impair performance, cause unnecessary overhauls, create costly delays and shorten the life of any precision equipment.

And when you specify, be sure it's AIR-MAZE—the patented, all-metal air filter providing higher air filtering efficiency with extremely low pressure drop—scientifically designed to utilize the baffle impingement principle in its highest degree.

Made in a wide range of sizes, shapes and capacities to solve nearly every air filtering problem. For further information, without obligation, write us direct.

AIR-MAZE CORPORATION
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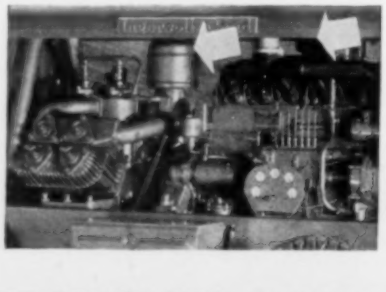
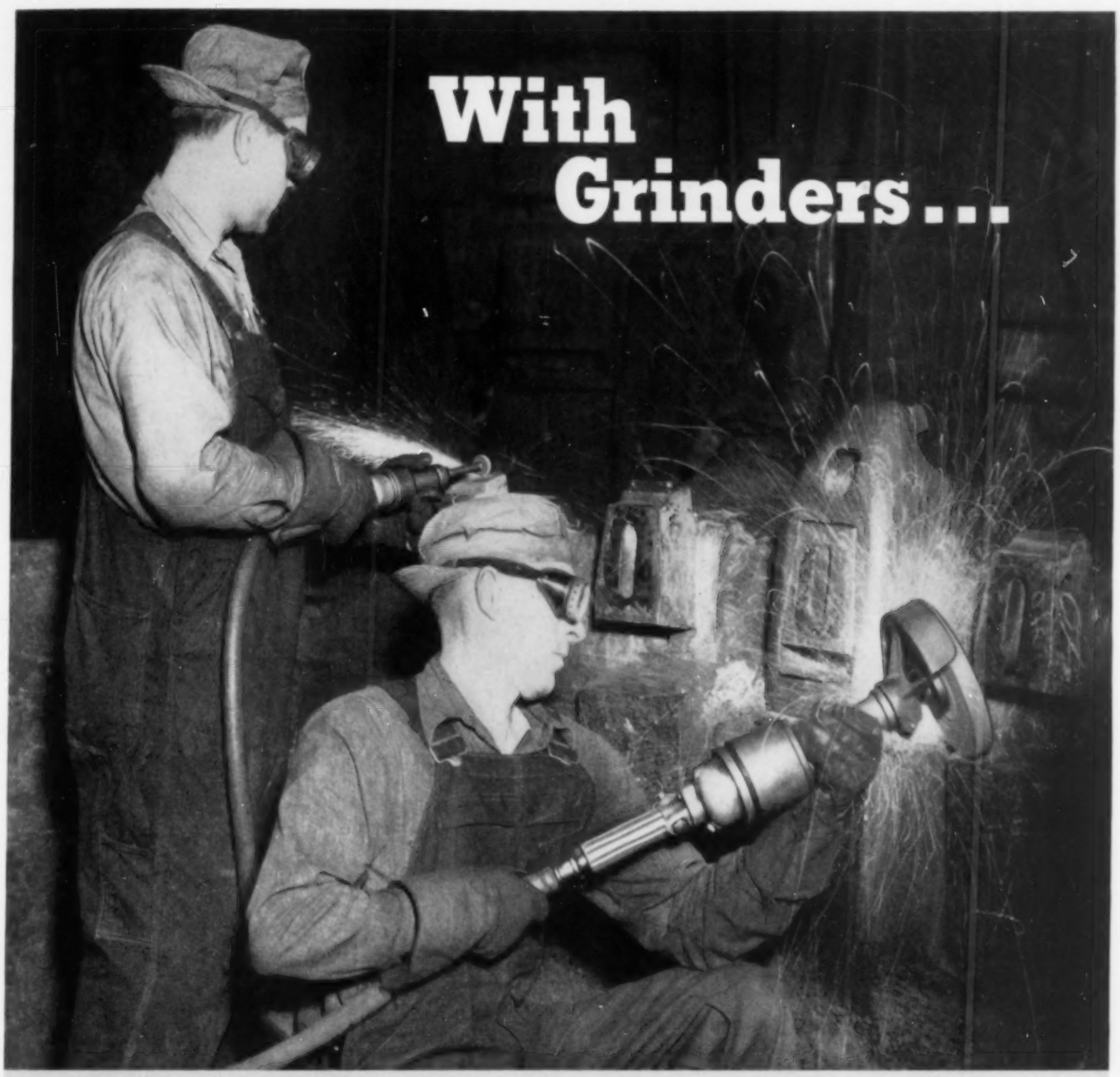


THIS PORTABLE *engine-driven compressor is doubly protected by AIR-MAZE. Both air intake of compressor and engine are equipped with AIR-MAZE Oil Bath Type Air Filters, shown by arrows.*

AIR-MAZE

DEPENDABLE AIR FILTERS FOR EVERY APPLICATION


With Grinders...

It's Metal Removed Per Shift That Counts!

With Ingersoll-Rand "Multi-Vane" Grinders you get maximum grinding efficiency. Their design incorporates three most important features—great power—light weight—and sensitive control. With these modern air tools your operators can do more work with less fatigue — remove more metal in less time.

8-97

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WAR TIME IS NO TIME
TO GAMBLE

Grind Your Carbide Tools Right for Maximum Life

Three Types of Norton Wheels Meet All Requirements

YOU can't afford to take chances today with your cemented carbide cutting tools—every possible minute of useful life from each one is absolutely essential. Therefore you must play safe when you buy tool grinding wheels—must be sure they can do their work right.

From the very first introduction of cemented carbide tipped tools, now so important in armament production, Norton has been a pioneer in developing wheels for grinding them. First it was Crystolon wheels in the proper grain, grade and structure to handle these superhard cutting materials. Then came the first diamond wheel—the Norton Resinoid Bonded—and later the outstanding Norton Metal Bonded Diamond Wheel. Now all three types—each having its special field—are available to users of carbide tools for the production of the many products essential to victory.

Norton engineering service is ready to assist you with the correct grinding methods for all kinds of tool grinding jobs—not only on carbide tools but also on high speed steel and Stellite tools using the patented "B-E" bond wheel.

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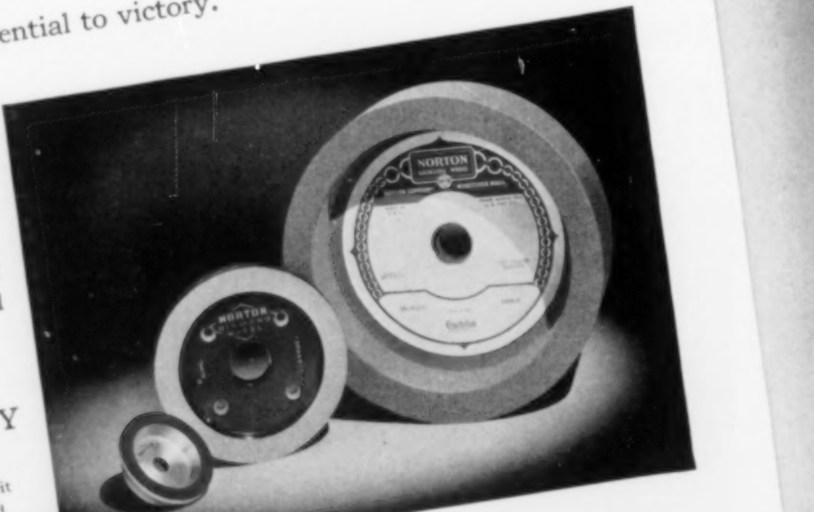
NORTON ABRASIVES



ON THE COVER

OUR cover picture shows a Pueblo Indian woman weaving a sash. The technique differs from that employed by the Navajo rug weavers (see page 6658), but from it the latter probably learned how to weave different patterns on opposite sides of a rug. In sash weaving, the design is made of the warp, which is soft yarn. The weft is hard string which is pulled tight and disappears, while the lengthwise-running warp shows up.

•

IN THIS ISSUE

TIMELY, indeed, was the creation of The David W. Taylor Model Basin where naval architects eliminate guesswork concerning the performances of projected ships by testing models of their hulls in advance. This unexcelled establishment is now serving Uncle Sam well in his task of turning out seaworthy and battleworthy fighting craft. It is also proving of great value to builders of merchant vessels. In our leading article, Robert G. Skerrett describes the new basin and explains how it is used.

•

MANY persons visiting the West for the first time have returned home with what they thought was a Navajo rug, only to learn that it was a spurious machine-made product of little value. Yet it is easy to tell the genuine from an imitation, as is pointed out in this issue. Navajo rugs are a distinctive article of native handicraft that combines beauty with utility. Moreover, they are inexpensive, compared with other handmade rugs that will last a lifetime or longer.

•

AFTER the reservoir behind Grand Coulee Dam is filled with water, upstream conditions along the Columbia River will be greatly changed during flood stages. To bring the stream under control, engineers have widened the deep gorge at the Little Dalles, as described in a 2-page article.

•

OVER a route that Marco Polo traveled centuries ago, vital war supplies borne in American-made trucks are pouring into China. The Chinese rebuilt this remarkable highway, which is called the Burma Road, but American traffic experts are responsible for the system by which it is operated and which has speeded up the movement of freight. For much of the material embodied in our article we are indebted to *The Lamp*, publication of the Standard Oil Company of New Jersey.

Compressed Air Magazine

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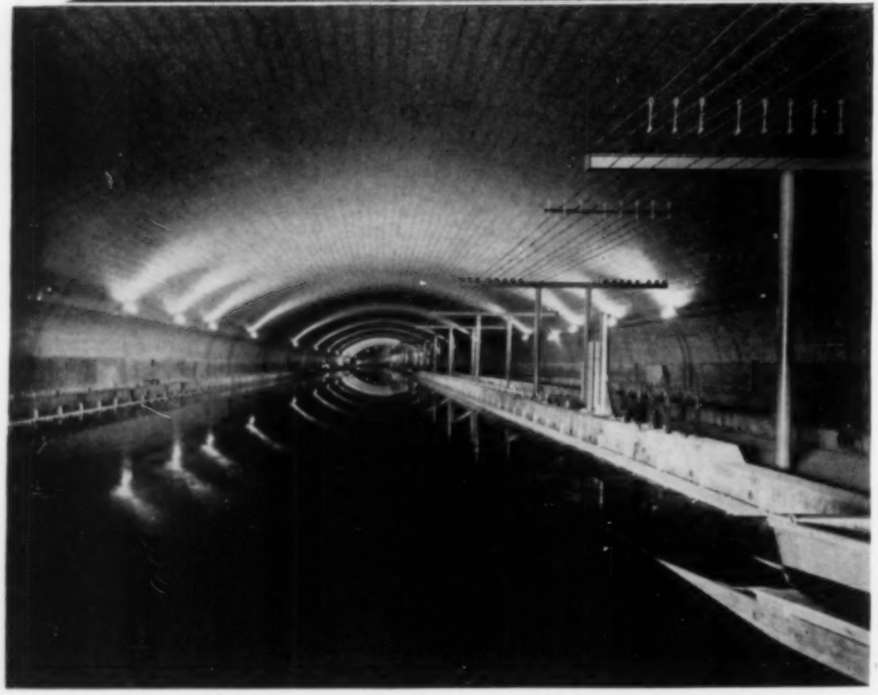
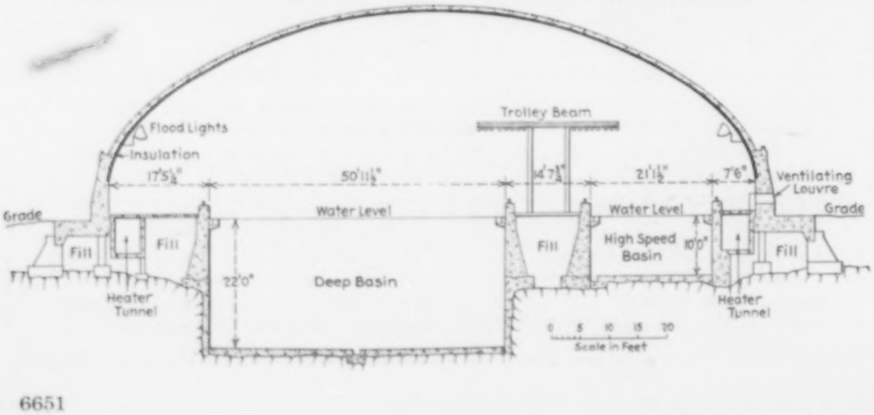
Testing Our Battlecraft Before Building Them

Robert G. Skerrett

Official U. S. Navy Photograph



Courtesy, Turner Construction Company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Insulation
17'5½"
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Trolley Beam
14'7¾"
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Ventilating Louvre
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Water Level
Water Level
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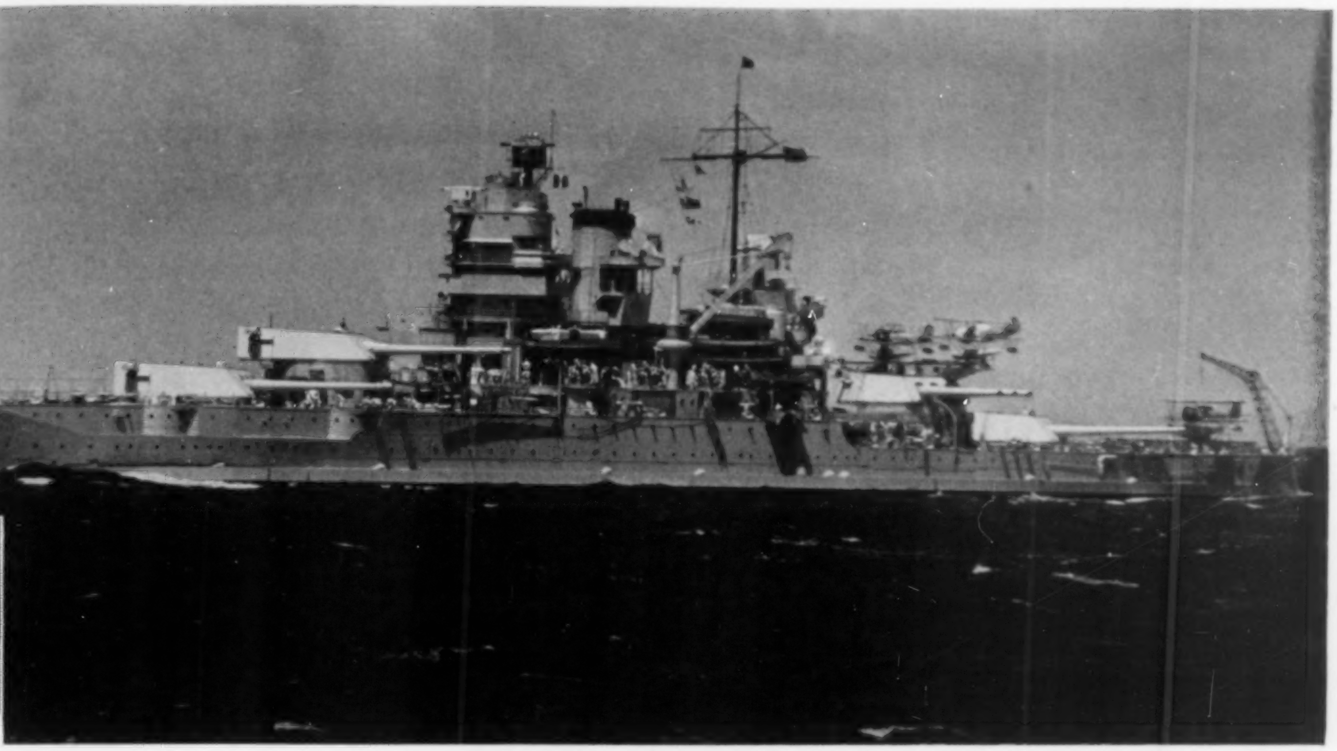
High Speed Basin
10'0"
22'0"
Deep Basin
Heater Tunnel
Heater Tunnel
0 5 10 15 20
Scale in Feet

WE ARE hard at it building the largest and finest fleet of battlecraft we have ever had. That those vessels shall be second to none, the Navy Department has recently placed in operation at Carderock, Md., The David W. Taylor Model Basin at a cost of $3,500,000. It is really a group of basins, and is the largest and best-equipped plant of its kind among the 40 others elsewhere in existence. The Carderock basins will take over the work heretofore done by the Government at the U.S. Experimental Model Basin in the Navy Yard at Washington, D.C. The latter was constructed at an outlay of $100,000, and only after Congress had been asked for funds for twelve years. During that period of nonresponse the Government paid more than $2,500,000 to our shipyards as bonuses for speeds in excess of contract requirements for new naval vessels—paying as much as $50,000 for each additional quarter knot. The excuse for this, by implication, was that the designers of the Navy were not certain of the correctness of their estimates of the needed power and possible speed. The truth is they were under a handicap that no mathematical wizardry could offset. At last, in 1896 and 1897, Congress saw the light and appropriated funds for the basin. Since then, no bonuses for extra speed have had to be paid.

The U.S. Model Experimental Basin was designed and built under the direction of Naval Constructor David W. Taylor; and from 1899 to 1914 he was in charge of it. Thereafter until 1923, when he retired from active duty, he was Chief Constructor and Chief of the Bureau of Construction and Repair. The name chosen for



FOR BETTER SHIPS

Our fleet, of which the 35,000-ton battleship U. S. "Idaho" (above) is an impressive example, can do its work more effectively because of model tests that are conducted before the final hull lines and propulsion plants are determined. The new David W. Taylor Model Basin in Maryland gives us unequaled facilities for carrying on this important work. The main building, with part of the basin building projecting from behind it, is shown at the upper left. Below it is a view from one end of the deep-water basin. Paralleling it on the right is the high-speed basin. Note the trolley system that supplies operating current for the towing carriages. A cross section of the basin building, with dimensions, appears at the lower left. All basin walls, footings, and piers rest on bedrock.

the Carderock plant is a tribute to his work and to the continuous record of the staff of the U.S. Experimental Model Basin.

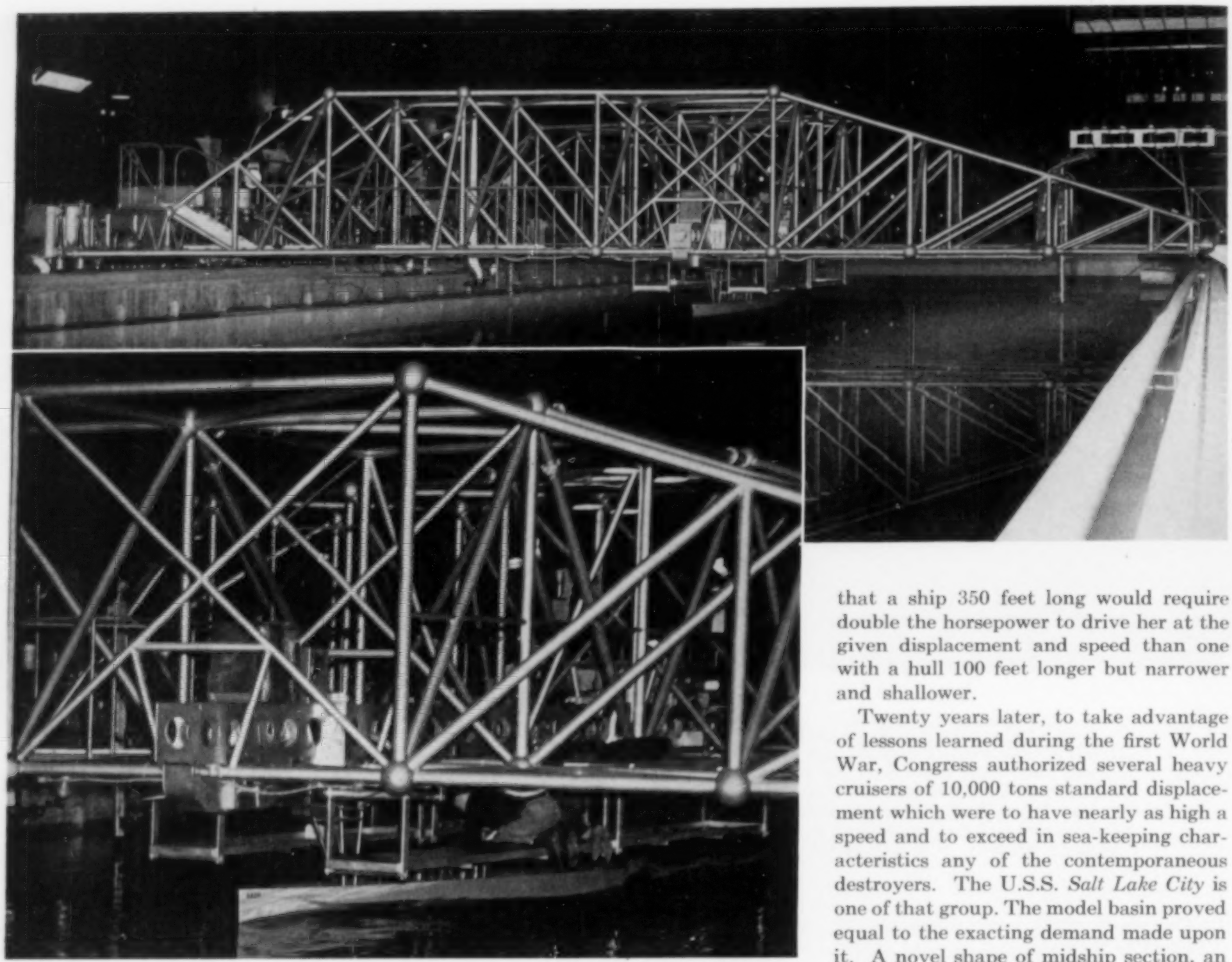
All model-towing basins are based upon the pioneer work of William Froude, a versatile English engineer, who started in 1867 to tow small models, similar in form to full-size ships, in an effort to solve a major problem in naval architecture that had become increasingly pressing because of the insistent demand for faster and more efficient steam-propelled craft. Through his private researches—time and again viewed with skepticism by shipbuilders and designers of his day—Froude prevailed upon the British Admiralty to grant about $10,000 to make tests just when the Royal Navy was faced with the need of fighting ships of improved speed and higher military characteristics. Even at a financial loss to himself, Froude proved the correctness of his fundamental theory and the value of model-towing tests.

Froude revealed how inexpensive models could be towed; how the power or pull required to tow them could be ascertained at modest expense; and how the data so obtained, with the aid of Froude's law of comparison, could be used in determining the propulsive power needed for a full-size craft of similar geometrical shape. Further, he showed that the same method would enable a designer to find the best hull form to meet specifications, instead, as formerly, of constructing a vessel, that often fell seriously short of expectations, at a large outlay. Froude laid the foundation upon which later naval architects and marine engineers have built and improved by evolving formulas to bridge gaps that inevitably arise in translating model performances into those of a proposed full-size ship of the same hull shape when traveling at "corresponding speeds."

Corresponding speed is the square root of the ratio of the length of the model to the length of the vessel multiplied by the given speed of the large craft. For example, a 14-foot model at 3.85 knots will have the corresponding speed of a geometrically similar hull 500 feet long when running at 23 knots. The resistance of the model would be measured in a few pounds and fractions thereof, while the corresponding total resistance of the big ship might possibly amount to many tons. This difference indicates the need of the utmost precision in measuring the performances of a model which have to be increased as the square or higher powers in calculating the total resistance of the projected full-size vessel.

The total resistance encountered by a ship in driving herself through the water is, broadly, the sum of the frictional resistance induced between the wetted surface of the hull and the passing water and the resistance resulting from the generation of waves, eddies, etc., which is known as the residuary resistance. Froude was the first to separate these two resistances and to evaluate the characteristics of a hull in relation to speed and propulsive power. Frictional resistance is not appreciably affected by form. For a model, that resistance can be ascertained separately merely by towing at model speed a thin plane of the same length as the waterline length of the model, having an area similar to the wetted surface of the model, and being of like finish or relative roughness. The resistance so measured, when subtracted from the total resistance of the model, leaves the residuary resistance, which is influenced by hull form.

Having determined the residuary resistance of a given model, the research experts are guided by their experience and accumulated data in modifying the hull shape in seeking better results. It may be necessary to construct one or more additional models to reach an acceptable compromise within the limits fixed by military requirements in the case of a naval vessel. The goal is a hull form for a full-size ship that can be driven at the desired maximum speed with the least



Official U. S. Navy Photographs

TOWING CARRIAGES

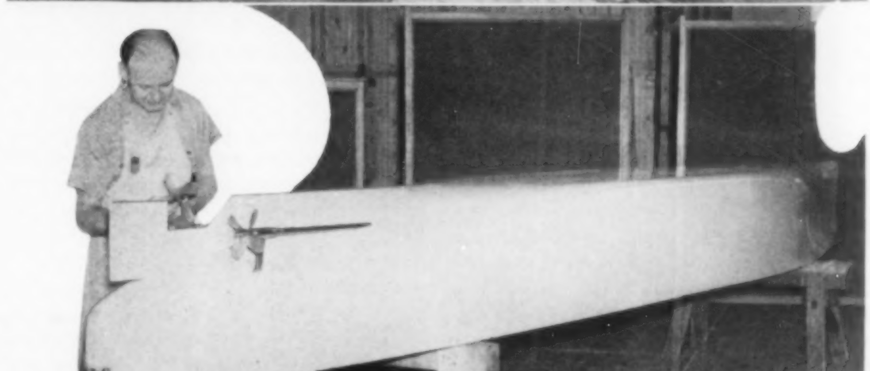
At the top is a general view of the towing carriage spanning the deep-water basin. The driving mechanism is at the left side and the right end travels on the steady rail. A ship model is attached to the underside and midsection of the carriage. The lower view shows a model under test. In this case it is being driven by its own propellers, which are connected to motors inside the small craft as well as to special dynamometers for indicating thrust, torque, and revolutions per minute.

expenditure of power. Any excess horsepower entails heavier initial outlays, higher maintenance charges, greater consumption of fuel, and increased dead weight if the craft is to be able to cover a given total run between successive refuelings. Each fighting ship involves very skillful juggling of different weights to give her a maximum of efficiency when measuring forces with an enemy. The foregoing is an outline of the broad nature and purpose of model-towing tests, without touching upon the difficulties and intricacies of this field of research.

When the U.S. Experimental Model Basin had been operating for about three years it was called upon to develop hull forms for two identical armored cruisers, each of 14,500 tons displacement and planned to carry more powerful batteries than two preceding ships of the same class but of lesser displacement. The outcome was hull forms for vessels 820 tons larger that could be driven at 22 knots with measurably lower horsepower than the two earlier craft. About the same date a number of torpedo-boat destroyers failed to make their maximum contract speeds on their acceptance trials—the shipbuilders attributing the disappointing showing to the hull forms designed in the Navy Department. The contractors proposed fairly extensive changes entailing outlays of from $30,000 to $40,000 for each craft. A few comparatively inexpensive model experiments disclosed that slight alterations, costing on an average $2,500 for each destroyer, would assure even better results. When the Navy designed the first of its scout cruisers—a novel type in 1904, the initial plan was for vessels of 4,000 tons displacement, 350 feet long, and a maximum speed of 26 knots. Model tests, however, revealed that a ship 350 feet long would require double the horsepower to drive her at the given displacement and speed than one with a hull 100 feet longer but narrower and shallower.

Twenty years later, to take advantage of lessons learned during the first World War, Congress authorized several heavy cruisers of 10,000 tons standard displacement which were to have nearly as high a speed and to exceed in sea-keeping characteristics any of the contemporaneous destroyers. The U.S.S. *Salt Lake City* is one of that group. The model basin proved equal to the exacting demand made upon it. A novel shape of midship section, an entirely new form of underwater body for the stern, and a bulb bow resulted in full-size vessels capable of making more than 32 knots. The bulb bow, which is an enlargement below water, makes possible sharp lines at the water surface and thus reduces the bow wave and places it rearward of the cleaving stem. Ships so designed require lower driving power at maximum speed. The same feature has since been adopted for many types of our fighting vessels and is now found even in merchant craft.

In the field of academic research, the basin at the Washington Navy Yard has given naval architects and marine engineers data of great value and has won world-wide recognition. Model tests made there brought to light the true nature and the amplitude of suction between passing ships that had previously been loosely termed "a mysterious force" and that had repeatedly been strong enough to pull vessels together despite all their helmsmen could do to keep them apart. It was that type of interaction that brought about the collision between the S.S. *Olympic* and the H.M.S. *Hawke* in 1911, when the smaller naval craft swung to one side and rammed the overtaking and passing 45,000-ton liner.



MAKING A MODEL

All models have a standard length of 20 feet and are fashioned from a block made up of multiple layers of white pine joined together with wooden dowels and waterproof glue, applied hot. To consolidate it, a block is placed in a glue press (left) where a pressure of 50 pounds per square inch can be maintained for sixteen hours or more. The resultant block, upside down, is rough-shaped in a profiling machine (below). The final truing of the hull lines is done by hand. The bottom picture shows propellers being fitted to a finished model preparatory to a self-propulsion test.

Official U. S. Navy Photographs

Two years later the basin was fitted to represent, on a reduced scale, the lower section of the Hudson River, including simulated piers on both shores with small models of various types and sizes of ships moored alongside them. The purpose was to decide whether or not piers for two great foreign liners, then under construction, could be built farther out into the river without narrowing the channel and increasing traffic hazards should such a large deep-drafted liner be moving in it at certain tidal stages. A reduced-scale model of a 1,000-foot ship was run up and down the basin at corresponding speeds, and the reactions upon the craft at the piers and upon special buoys in the basin fairway were photographed by movie cameras. The extent and the nature of both surface and subaqueous disturbances were registered in their sequences. In consequence, the U.S. Army Engineers definitely fixed the limits of the pierhead lines and made the river safer than it probably otherwise would have been. So much for the background of our subject.

Congress voted funds for the Carderock plant in 1936, 1937, and 1938, but preliminary planning had been started in 1929 by the staff of the U.S. Experimental Model Basin, utilizing all that had been learned there and in other basins the world over. They kept in mind the needs both of the Navy and of ship designers and builders throughout the nation. The architectural and structural features were developed by the Bureau of Yards and Docks of the Navy Department.

The site of The David W. Taylor Model Basin is 11.3 miles from the Navy Department by motor highway, and was selected because bedrock for the necessary foundations for basin walls could be reached with moderate excavating. The reservation, of about 107 acres, is situated on a rock bench of the ancient gorge of the Potomac and at an elevation that affords a clearance of 20 feet above high floodwater level for the subdrainage system of the establishment. The location is also remote from any industrial or other activity that might cause objectionable noise, ground vibrations, smoke, or dirt. The contract for the buildings and their facilities was awarded to the Turner Construction Company, of New York, in August, 1937, and that concern completed its work in June, 1939.

The two conspicuous structures are the 871x54-foot frontal or main building and,

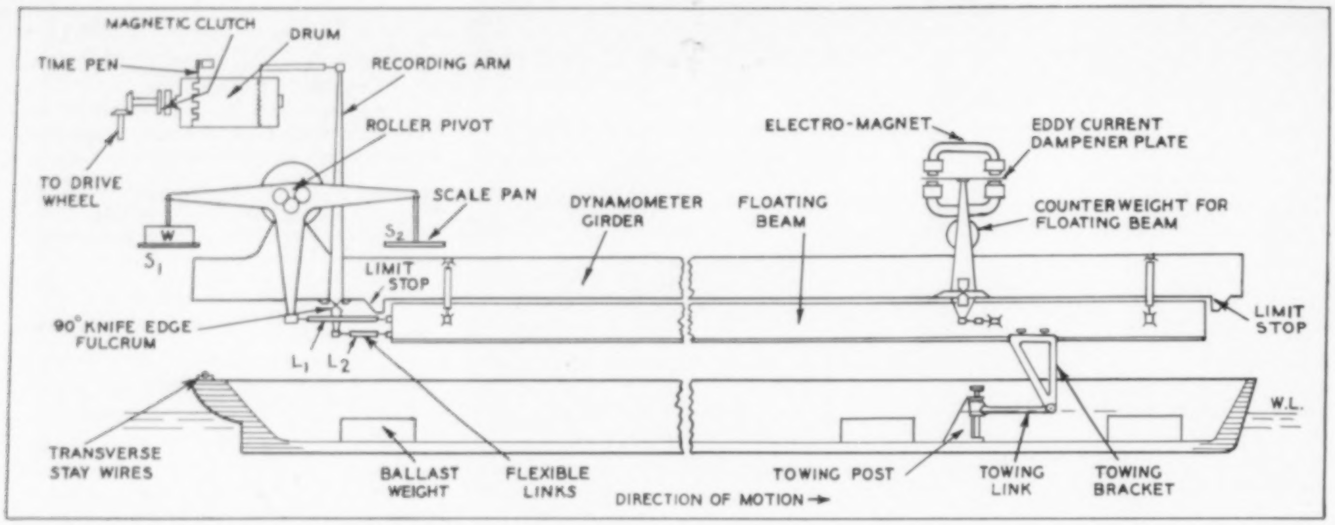


DIAGRAM OF TOWING DYNAMOMETER

The floating beam is hung from the dynamometer girder at two points by knife-edge yokes and is free to move between two stops like a pendulum. The towing bracket is secured to the lower edge of the floating beam and is connected, through a freely moving towing link, to a towing post placed forward in the model, the towing link being at the water line. Attached to the floating beam near its forward end is a vertical swinging arm on which is mounted a counterweight to keep the beam in equilibrium at any position between the limit stops. Eddy current, generated by an electromagnet, dampens any undesirable swinging of the floating beam. Model resistance is transmitted as a horizontal force through the flexible link L_1 to the vertical arm of the T-shaped balance at the left end of the assembly. At each end of the crossarm of this balance is a scale pan. It will be seen that any drag exerted by the model tends to lift the scale pan S_1. The operator in the carriage control station can adjust the weight in this pan to provide correct counterbalance. When the model resistance is not exactly offset by this weight, the remainder is taken up or applied by the resiliency of a group of spring supports. The amount of this auxiliary load or force is recorded on a card secured to the revolving drum at the upper left by the link L_2 and the recording arm. On the same card a time pen registers succeeding seconds, and another line shows the distance traveled at regular intervals.

paralleling it on the north, the 1,330-foot-long basin building which houses three model basins. The former is divided into three sections. In the center are the administrative headquarters, with offices, drafting and computing rooms, a reference library, record storage vaults, a photographic laboratory, and a museum. The adjoining section on the west contains shops for the fabrication of wooden models, for producing metal models for the study of the elastic properties of the structural features of ships, for making mechanical equipment and special appliances required for various tests, and for manufacturing the dynamometers and other instruments needed in model-basin research. On the mezzanine floor of this section is a small plant for making propellers for basin models as well as for testing in the variable-pressure tunnels of the establishment.

In the eastern part of the main building are installed a 12-inch and a 27-inch variable-pressure tunnel, a 30,000-pound and a 600,000-pound static load-testing machine, a 150,000-pound alternating load-testing machine, and other research equipment. Facilities are to be provided in this laboratory section for handling and testing structural models up to 30 and 40 feet long and 6 to 8 feet wide, for testing the vibration of ship structures, and for similar work. In the basement there is a relatively small model basin 142.5 feet long, 10 feet wide, and 5.6 feet deep for testing special forms, for preliminary tests with small models on unusual research problems, and for miscellaneous investigations in hydrodynamics.

The big basin building is of unusual design. Its westernmost part consists of a rectangular structure 105 feet long, and from there to the eastern end—for a length of 1,188 feet—it carries a reinforced-concrete barrel-arch roof that ranges in thickness from 8 inches at the crown to 12 inches where it meets the supporting side walls. Along the south side are the deep-water basin for testing ship models and the adjoining shallow-water basin for models of tugboats, river craft, and kindred vessels. The deep-water basin is 963 feet long, 51 feet wide, and 22 feet deep—providing ample leeway for towing models of the largest battlecraft at maximum model speeds. The shallow-water basin is also 51 feet wide, is 303 feet long, and the depth of water can be varied from a few inches to 10 feet. Its surface level is normally at the same elevation as the water in the deep basin; but the two may be separated by interposing a removable caisson somewhat similar to the gate of a graving drydock.

With the caisson out of the way, the shallow-water basin serves as an extension for the deep-water basin to give the towing carriage that much added run in working up to the required full speed. At its western end, the former connects with a J-shaped turning basin for testing the turning and maneuvering characteristics of a model. The towing carriage of the shallow-water basin is used to speed up a model on a straight run and to release it so that it will be free to propel itself under the guidance of its own rudder. A platform up under the roof of the building provides accommodations for movie cameras that photograph the target lights carried by the maneuvering model—the basin area being darkened the while. The maneuvering facility of a fighting ship is of importance when acting with other vessels, when shifting to gain advantage of an enemy, or in trying to escape an oncoming torpedo.

Along the north side of the basin building is the high-speed basin which was originally planned to have a length of 1,600 feet. At present it is approximately 1,168 feet long, 21 feet wide, and 10 feet deep; but it is to be lengthened later to about 2,400 feet. Its purpose is to test models of motorboats, high-speed craft, naval airplanes, pontoons, and friction planes. Its towing carriage is designed for a maximum speed of 30 knots, but, until the basin is extended, will not be allowed to run more than 20 knots. The models to be towed will range from 8 to 10 feet in length. A 10-foot model of a ship 100 feet long at 20 knots has a speed corresponding to about 63 knots for the full-size vessel. The towing carriage for the deep-water basin is built for a maximum speed of 18 knots; but for the majority of tests with the standard 20-foot models used there a top speed of 6 knots suffices. A 20-foot model traveling at 6 knots has a speed corresponding to 33 knots for a 600-foot battleship.

The basin building is without skylights or windows and is ventilated and illuminated by artificial means. Electric lighting permits local or general control of illumination to facilitate photographing models in motion. Heating units and fans, thermostatically regulated, handle air drawn in and discharged through louvers in the side walls near the ground level. In the wintertime the average temperature can be maintained at about 65°F. Closing in the structure prevents disturbing air currents, the admission of blown dust, leaves, etc., that might settle on the water; and artificial lighting can be held uniform day or night. Further, the elimination of sunlight was intended to arrest the development of aquatic growths in the basin water. A small quantity of algae has formed, but instead of being green it was white.

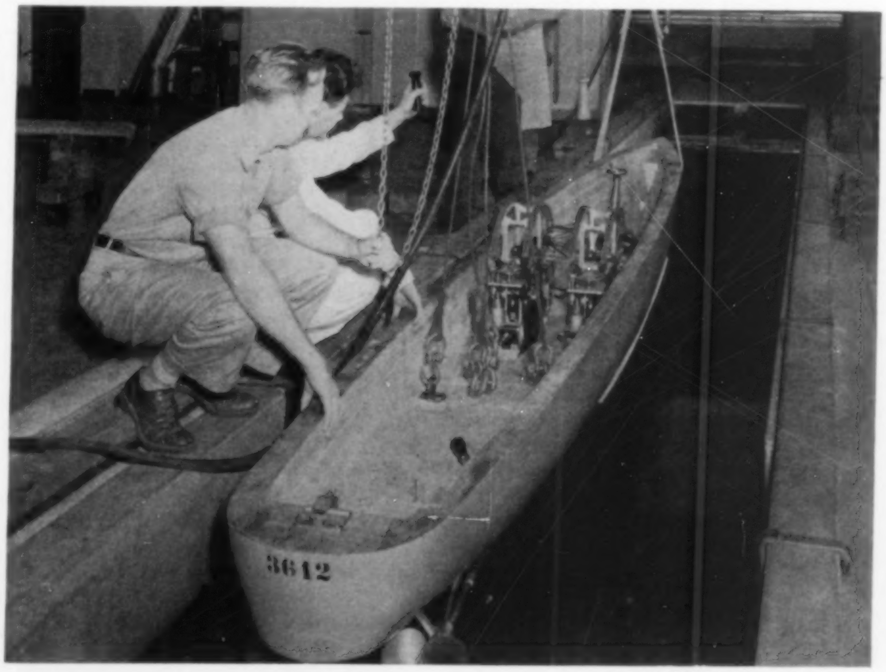
The reinforced-concrete basin walls were placed with the utmost care because they carry the rails upon which the towing carriages travel. Combined, the rails have a length of about 4,900 feet and are as level as it was humanly possible to make them. Their vertical variation does not exceed 0.005 inch, and they follow the curvature of the earth's surface so that the action of gravity on the towing carriages is constant: their lateral variation within any one length of 50 feet is no greater than 0.005 inch. They were laid with microscopic and electric precision checks and secured so firmly that the vertical deflections in the top surface of any rail when a carriage wheel passes over or adjacent to a given point does not exceed 0.001 inch. No wonder this part of the work took fifteen months to complete.

A towing carriage has the plan outlines of an isosceles triangle, spans the basin, and travels on two rails, one on each side. That on which the base of the triangle is carried weighs 165 pounds per yard—comparable to the heaviest members used in railway service—and is called the main rail. The opposite one, on which the apex of the triangle rests, weighs 100 pounds per yard and is called the steady rail. As the center of gravity of the carriage is only a few feet out over the base away from the main rail, the system is in principle virtually a monorail one. Four flangeless driving wheels, equally spaced longitudinally, run on the heavy rail and are attached to the base girder of the carriage. At each end of the girder are two pairs of horizontal guide wheels that bear against opposite sides of the rail head and keep the driving wheels from swerving. The light end of the carriage has two flangeless wheels that run on the steady rail.

The top and bottom of the main rail were precisely ground to make them parallel, and the sides of each rail head, which are at right angles to the top bearing surface, were similarly treated. Rail-end heads have a 45° miter to obviate any battering action where sections are joined and to assure smooth passage for the wheels. The rails are secured by through bolts to supporting cast-iron chairs which are, in turn, anchored to screw bolts embedded deep in the basin wall. All wheels are mounted on tapered roller bearings that reduce friction and minimize any unbalancing drag, particularly when the carriage is towing a model. The shallow-water-basin carriage is the first to be installed. It weighs 85,500 pounds, of which 72,800 pounds is borne by the four driving wheels.

Four oil motors, each direct connected to a driving wheel, propel each carriage. The motors receive their impulse from four oil pumps that are driven in pairs by two synchronous motors. This arrangement provides variable control and permits the carriage speed to be regulated, as desired. During deceleration, the oil motors function as pumps, the pumps as motors, and the synchronous motors as generators, thus pumping power back into the line. A carriage can be accelerated and decelerated with astonishing smoothness and given a uniform motion at a speed as low as 0.10 knot. The aim has been to achieve a carriage speed that will be uniform within a variation of 0.01 knot under operating conditions. As explained by Capt. Harold E. Saunders, technical director of the new plant: "Under the Washington Navy Yard carriage, the resistance of ship models could as a rule be measured accurately only to within about 0.1 pound. This limit of measurement of course varied widely with the size, weight, and type of models." The basins at Carderock will, therefore, yield results of far greater exactness. At midspan of each carriage is a towing dynamometer of the so-called floating-frame weighing type which is shown and described on the opposite page. By shifting the towing bracket and making minor adjustments, this device may be used with equal success when the carriage travels back to the starting point.

In making a towing run, a carriage starts from standstill and attains gradually and smoothly the required full speed, the model developing the while its characteristic wave formation and inducing a steady flow of the water in contact with its wetted surface. Then, at the given test speed, the carriage must tow the model at uniform velocity. In the deep-water basin the maximum speed is 18 knots and must be held for a registering period of eight seconds. Eight seconds is not a long span, but it is ample to measure with extreme closeness the actual resistance of a model in pounds and hundredths of a pound—the equivalent of many tons in the case of a large ship traveling at possibly 35 knots. A 20-foot model, weighing about 2,000 pounds when tested, may be used to ascertain the best hull form for a battleship of 35,000 tons displacement that is expected to make a maximum sea speed of 26 knots. These extremes in size emphasize the need of utmost precision in the model basin in order to determine the propulsive power delivered to the water by a large ship's screws when driving her at her highest speed. The required data are not obtained entirely by towing a model: it is equally important to learn how a model's resistance may be increased



Official U. S. Navy Photograph

LAUNCHING A SHIP MODEL

This craft is equipped with motors and propellers and provides its own power when being tested under a towing carriage.

by bilge keels, propeller-shaft supports, and by the actions set up by the screws themselves. Therefore the models are equipped for self-propulsion for this phase of the research work.

For self-propelled tests the screws are driven by electric motors that function as dynamometers. These are put in a model; but their speed is controlled through a rheostat that is regulated by the operator at the recording mechanism on the carriage, to the towing bracket of which the model is attached. The operator brings about a balance between the speed of the model and the exact speed of the carriage, at the time. Incidentally, the propulsive effectiveness of the propellers is ascertained; and a run may disclose the need of other screws to make more efficient use of the power supplied them. Here is where the two variable-pressure water tunnels play an important part. These tunnels test model propellers having maximum diameters of 8 inches and 18 inches, respectively. A screw when undergoing test is attached to and driven by a shaft that projects into the tunnel from a dynamometer that registers the thrust and torque of the propeller at different speeds of revolution. The screw operates in a stream of water flowing toward it from a nearby nozzle that discharges at a carefully regulated uniform flow and turbulence.

An ingenious lighting system makes the revolving propeller seem to move slowly or even stop; and either still or moving pictures of a rapidly rotating screw can be taken so as to show movements of the water as well as any stages of cavitation. Cavitation is, in effect, a partway vaporizing or reduction of hydrostatic pressure about a rapidly revolving screw and diminishes the effective work of a propeller. The form, size, and speed of a screw, together with its depth of submergence, have a bearing on the development of cavitation. All water used in the variable-pressure tunnels is filtered and deaerated; and the vacuum pumps that deaerate the water that fills and makes the circuit of a tunnel also lower the air pressure above the water in the observation or testing chamber of the tunnel. This is done to create an "absolute pressure" on the model propeller corresponding to the combined effect of atmospheric and water pressure on the propeller of the full-size ship.

The variable-pressure tunnels enable the researcher to make valuable tests and to pick the best form of screw for a given application. With that question settled, the problem becomes an internal one, which the naval engineer must solve by devising a power plant that will transmit to the propellers a maximum of the energy generated in the boilers. Back in 1871, William Froude discovered by towing tests that only 42 per cent of the indicated horsepower of the engines of a 1,000-ton ship was available as effective horsepower at the propeller. Although the marine engineer has made long strides since Froude's day, still the urge towards betterment continues, and the model basin is a prime means in this quest.

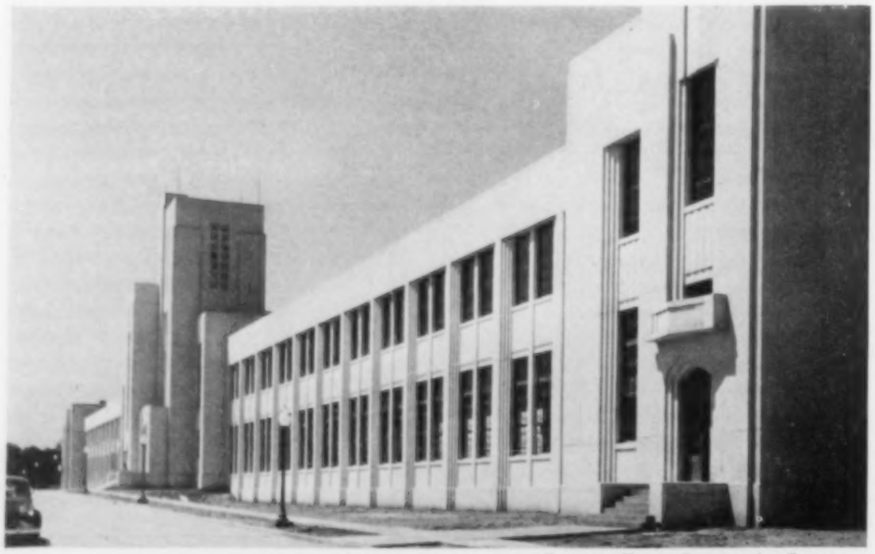
All models tested at Carderock are of white pine. Although those used in the deep basin have ranged from 13.4 to 30 feet in length, the standard is 20 feet and serves for vessels ranging from destroyers to battleships. So far as feasible, machine tools are employed in shaping models to their approximate forms, and skilled woodworkers finish them to the exact lines and contours required. Each model is made of multiple lifts or layers, cut from heavy planks, which are pinned together with wooden dowels and consolidated into a rigid "block" with waterproof resin glue that is applied hot.

When a block is ready it is placed in a model-profiling machine. This makes transverse saw cuts guided by wooden templates of cross sections transcribed from the body plans by a pantographic instrument that does it to scale. The cuts are fairly close, and the surplus wood between the slots is knocked off. Rotary cutters are then substituted for the profiling saws to rough-finish the model, and the precise truing of the hull lines is done by hand. The smooth surface is next spray painted or coated with a quick-drying enamel. The average cost of a model ready for towing is $400. Besides doing spray-painting, compressed air is used in the model shop for cleaning up and also for the forced lubrication of various machines. The total outlay for models and running tests for a battleship that will possibly cost a great many millions of dollars may range from $1,500 to $3,000—certainly a relatively insignificant sum to spend in making sure that the giant craft will come up to expectations in time of conflict.

The Government's two model-basin plants have been working overtime for many months not only on battlecraft and their diversified auxiliary vessels but also on the designs for the splendid ships built and building for the U.S. Maritime Commission. This testing work has assured excellence in ultimate performance and operating economies mounting into millions of dollars. The establishment at Carderock has room for more than doubling its capacity and for additional facilities that will be needed in the years to come. The plan is to place two wind tunnels there to aid in aeronautical research and testing for our fighting fleet.

Capt. Harold E. Saunders, the technical director of the plant and long a member of the former Construction Corps of the Navy, was on duty at the Washington Navy Yard basin and was assigned to the work of planning the new one. He also had an active part in connection with its construction. In this sequence of service he has closely followed the part taken by the late Rear Admiral David W. Taylor in the planning and subsequent direction of the U.S. Experimental Model Basin at the Navy Yard. The Carderock plant is under the Bureau of Ships of the Navy Department, a recent consolidation of the Bureau of Construction and Repair and the Bureau of Engineering.

Although Congress long hesitated to provide the initial $100,000 for the basin at the Washington Navy Yard, it has done generously for Carderock in starting out the plant on its present scale. This is really recognition of what the old basin has done and faith in what the new one may confidently be expected to do in promoting naval architecture and marine engineering to the advantage of the nation in times of either peace or war.



Courtesy, Turner Construction Company

EXTERIOR OF CARDEROCK MAIN BUILDING

In this structure are the administrative offices, shops, laboratories, and a small model basin.

Navajo Rugs

Fremont Kutnewsky
and
Carey Holbrook

If HE believes in signs, the motorist touring in the West must have a wholesome respect for the fortitude and traveling ability of the Navajo Indian. At Oklahoma City, 700 miles from the Navajo Reservation, he will come upon an Indian trading post advertising Navajo rugs for sale. If he turns to go South he will find that some Navajo brave has apparently ridden all the way to Mexico to barter his rugs to an Indian trader. And when he gets to California he will be amazed to see another Indian trading post not far from Los Angeles. After viewing all these and other outlets for Indian floor coverings, he is likely to reach the conclusion that the Navajo Indian is a hard-riding son-of-a-gun when he wants to swap a rug. Of course, the truth is that these so-called Indian trading posts are curio shops that buy their rugs from some trader on the Navajo Reservation, for the Navajo himself seldom gets very far from his stamping ground.

The Navajo rug is perhaps the only large-scale product of American handicraft that cannot be successfully duplicated. In the first place each one is the weaver's individual creation. In the second place there are 7,000 or 8,000 weavers who never make two rugs alike and never make a rug exactly like any other rug. It would be hard to imitate on any scale a product which is identified only by type, and for which there is no standard as to size, color, pattern, or dimensions. Anyone with plenty of patience could learn to weave a Navajo rug, but few would be willing to turn them out as the Navajo women do, at a little more than a dollar a pound. No power loom has ever been built that could duplicate the true Navajo weave.

When you go back to the beginning of the industry you speak of Navajo blankets, not rugs. They were made to wear, and were worn until the white man turned them into floor coverings; and then, of course, they became rougher and coarser. The first Navajo blanket, so far as research has discovered, was woven around 1800. It is 49x69 inches in size, and the decorative scheme consists of alternate brown and white stripes running lengthwise. This and many other fine examples of the Navajo weaver's art are on display at the Laboratory of Anthropology at Sante Fe, N. Mex.

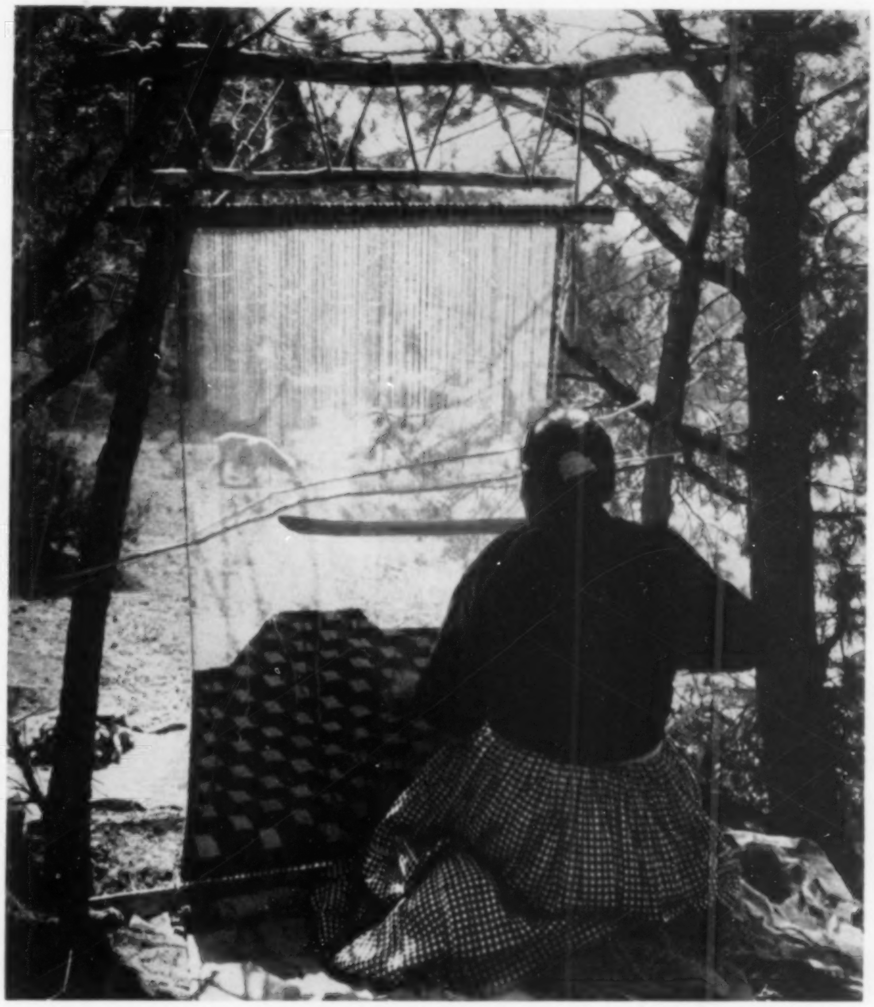


Photo by Ferenz Fedor

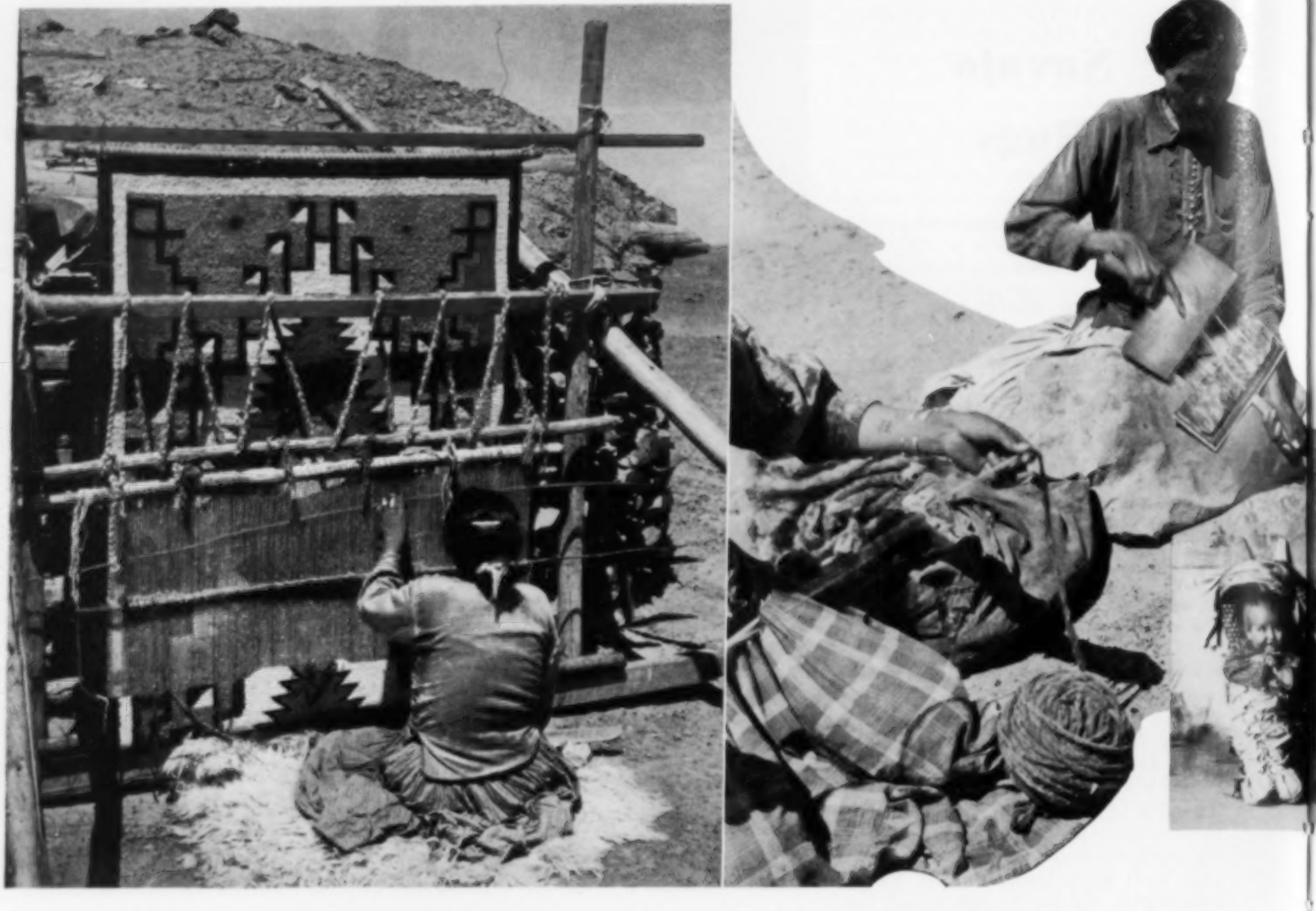
NAVAJO WEAVER

In summer, many rugs are made in a setting such as this. The woman is a sheepherder's wife, and one of the animals may be seen through the warp of the loom. Camp is moved every week or so to give the sheep fresh grazing; and the loom is made so that it can be readily put up or taken down. The location is on Chuskai Mountain, about 30 miles from Gallup, N. Mex.

The Navajo Reservation lies in the northwestern part of New Mexico and in northeastern Arizona. It now comprises 25,000 square miles of some of the most rugged and primitive—and driest—country in the United States. In this area live 49,185 Navajo Indians—10 per cent of all the Indians on United States reservations. An official report shows that their 1940 income amounted to $4,027,530, or $81.89 per capita. Of this sum, $348,300 came from rugs, the average price received being $1.12 a pound. In making these rugs the Navajos consumed 624,072 pounds of wool having an average value of 22 cents a pound. At the close of the year the tribe owned 431,934 head of sheep. Sales of sheep yielded $584,650 and of wool $505,740. Indebtedness to traders at the end of 1940 was $561,170, of which $370,500 was carried on account and $190,670 represented loans made on pawned goods.

Contrary to the way of the Pueblo Indians, who are villagers and who join their homes together in long, winding rows, the Navajos shun community life. They spread their hogans (the characteristic log and mud huts of the reservation) like summer campers who want to be by themselves. They are a clannish people and tend to form groups according to geographical divisions. A group living in an area on one side of a mountain may hardly understand the idiomatic lingo of those on the other side. This is just another evidence of the fact that the Navajos are great individualists, and a good reason why there is no attempt towards organization or coördination of their rug weaving. To them, it isn't an industry. It's an avocation, something like a hobby out of which the hobbyist makes a little money on the side.

Nearly all Navajo weavers are women, but not all Navajo women are weavers.



WORKERS AND HOGAN

The loom shown above is supported by the hogan, or dwelling house. Stone-walled hogans such as this one have been introduced but recently on the Navajo Reservation, the usual building material being adobe. The upper woman in the picture at the right is carding wool: the other one is handling yarn.

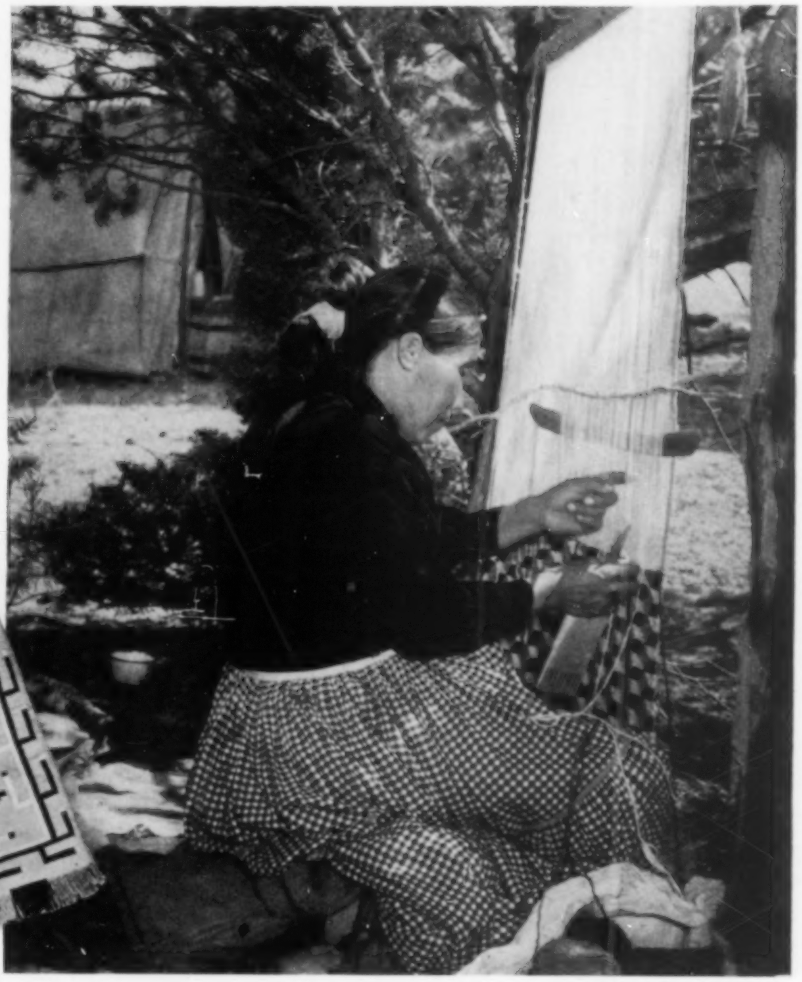
Those who are expert get a lot of pleasure out of demonstrating their creative skill, and would continue to weave if they had to give the rugs away. They frequently do give them away to white friends who have done them favors. The rugs are marketed through licensed reservation traders all of whom have their own clientele or buyers; and by tactful criticism they guide the weavers in their particular territory towards what they consider the most profitable patterns and textures. This adds variety to the rugs produced in different areas; but foremost of all is the fact that the weaver is an artist. She weaves designs "out of her head" just as a painter creates his pictures. She probably couldn't turn out two rugs exactly alike if she wanted to. Each rug has all the charm of an individual piece of work; and as the Navajos are experimenters by nature, the variety is endless.

Nobody knows at any given time how many Navajo women are weaving rugs. Those who own sheep, or whose husbands are herders, are likely always to have one in the making. In the summer they follow the herds, and set up their crude and simple looms wherever they happen to camp. But Government work and the introduction of farming and cattle raising have had a settling influence on many, and their looms have a place in the hogan, or in the shade of a nearby tree. Not being a business, weaving is something that the Navajo woman does in between other numerous household duties. She may produce a rug in a month, or it may take a year, depending on the size and the number of interruptions she has had to contend with.

Rugs are of all sizes, and they differ in the number of colors used and in the quality of the spun yarn and of the workmanship. While the trader pays for them by the pound he takes these other items into account. Prices vary with the price of wool and the general economic condition of the country. During the depression the Navajo weaver received as little as $2.50 for work that took weeks, and she furnished her own wool yarn, too. However, if the trader paid her with a fat basket of food or miscellaneous other merchandise she felt quite satisfied. After all, she no doubt thought, "I took wool off my own sheep and by the skill of my hands turned it into something my family could eat or wear." The Navajos sense the value of things much more keenly than that of money.

Navajos prefer their own little tough sheep to the higher breeds that the Indian Service is trying to induce them to raise. The Navajo sheep is accustomed to an environment where both water and feed are often scarce. It packs around only from 2 to 4 pounds of wool; but that wool is clean and desert dry. Finer breeds will produce from 6 to 16 pounds of wool; but it will be long and oily and consequently full of sand and burrs.

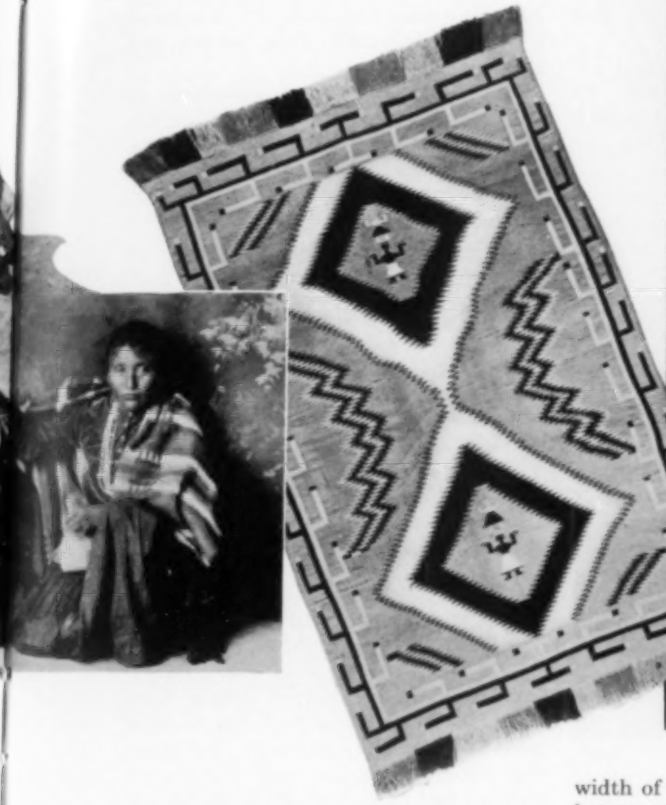
Carding by hand is hard work, and washing is not so simple a matter in a country where water for human and household use has to be hauled over long, hot, difficult miles. The wool from Navajo sheep cards readily, and in the process it becomes more or less clean—the dirt dropping out the while. Some of it is even clean enough to spin without carding. Ordinarily, only the yarn that is to be white in the finished rug is washed: the wool that is to be colored gets a bath in



SHEEPHERDER'S WIFE

In the background (right) is the tent where the Navajo family lives its nomadic summer existence while the sheep are on the range. In front of the tent is a barrel for water, a supply of which is hauled up the mountain once every two days. Extending through a part of the warp of the loom is the wooden batten with which the sheds are formed while the weaver runs the yarn through with her fingers. In her right hand is the comb-like tool with which she pats down each thread after it is in place.

Photo by Ferenz Fedor



PAPOOSE, SQUAW, AND RUG

The Navajo wife has to cook, mind her children, and do much of the general work, hence weaving is a spare-time job with her. The rug pictured above is of unusual design and a fine example of the weaver's art. Fringe is found on but few rugs, and those that are so decorated are sometimes called squaws' rugs.

dye water. Analine dyes are mostly used; but there is a tendency to return to the old-fashioned vegetable coloring matter that gives the yarn softer hues.

Navajo spinning is quite simple. The wool is drawn in a loose cord around a stick about 18 inches long and having a heavy wood disk near the butt end. One hand spins the stick as the other guides the yarn, which may be respun one or more times to make it finer. Germantown wool was woven on the reservation for a time; but of late years most of the Navajos have gone back to spinning their own. It's the most profitable use to which they could put the pittance of wool from their desert-bred sheep.

The Navajo loom also is a simple, crude affair. The warp yarn is strung between two stout sticks a little longer than the width of the intended rug—the distance between the two defining the length. This loom is fastened by rope or hay-baling wire inside a larger, heavy frame. The poles that form the oblong upright frame may be 2 or 3 inches thick; and juniper, mountain oak, and pinon trees are usually nearby to furnish the necessary materials. Such a loom can be put together and set up in short order. It can be knocked down and moved about the same as a folding camp cot. The only equipment that has to be bought for weaving is a pair of tow cards.

The principal difference between Navajo weaving and the European style with horizontal looms is the amount of handwork involved. In ordinary weaving, for example, the yarn is attached to a shuttle which is thrown back and forth across the entire piece of work, the sheds through which it flies being created by mechanisms on the loom itself. The Navajo weaver makes her sheds with a couple of sticks called healds, and widens them with a flat piece of whittled wood that is known as a batten and looks like a toy sword without a handle. This is inserted flat in relation to the warp, and then twisted into the horizontal position to form a shed.

Clever, agile hands do most of the work in creating a design for a Navajo rug. The various colors in a pattern are each woven separately, and every time a thread is added it is patted in place with a narrow wooden comb which is held in the right hand if the weaving is done from the left. Sometimes part of a motif is finished on one side, or in the middle, as shown in some of the accompanying pictures. This proves that the weaver does not throw the weft clear across, but develops her pattern part by part, and color by color. It is something like embroidering. Experts say that the Navajos are the only people in the world who weave double-faced designs—that is, with a distinct pattern on each side. This fact was first recorded in 1890. Others may have a different color scheme on each side, but the pattern is identical, only in reverse. Of course, double-face weaving is not the everyday thing. It calls for special skill.

It is curious that the warlike, nomadic Navajos should have become the weavers of the Southwest, while the Pueblo Indians, who had been weaving from time immemorial, turned to other handicrafts —pottery, silversmithing, and making baskets. The Pueblos wove only cotton, the Navajos only wool. Spanish explorers in 1540 were amazed to find the Pueblos raising cotton and wearing garments of excellent cloth of their own making.

But the Navajos were far from being weavers when they first arrived in the Southwest not long before the advent of the Spanish. They apparently drifted down from the Northwest, as they are linguistically of Athapascan stock from northern Canada, Alaska, and the North Pacific Coast. It is an Athapascan trait to adopt the manners and customs of neighboring peoples. After 300 years of preying upon the Pueblos and the Spanish settlements, the Navajos acquired the Pueblo art of weaving, using the wool of the sheep the Spanish brought, and made a definite and lasting contribution to the culture of the Southwest.

Interesting, too, is the fact that the Navajos learned the best of their weaving technique from the Spanish—not as conquerors, but as slaves. In the course of many years of fighting, several thousand Navajos had been captured and put to work. The women who became expert weavers were highly prized, valued as high as $400 each. The Spanish people came from a wool-growing country, and they appreciated fine clothes. Therefore they furnished the wool and taught the best methods. Some of the finest weaving in Navajo history was done by these captives between the years 1850 and 1870, which is spoken of as the classic period of the art.

During that time much weaving was done with wool obtained by unraveling *bayeta*, a flannel cloth which the Spanish imported. It was usually red in color. Imported 3-ply yarns much like our modern Saxony and Zephyr were also used. To match the small size and the even machine spinning of those high-grade yarns, the craftswomen spun wool of a quality that has never been equaled in Navajo history. Many of the classic blankets of that period were woven with a slit in the center so that they might be worn as ponchos. Following this golden era, the trend was towards blankets of coarser and thicker texture to meet the white buyers' growing demand for rugs. The gaudier colors that came clashing into the fine old patterns also were the result of their taste, the idea of many of them being that harsh and glaring colors would make the floor coverings truly romantic and barbaric.

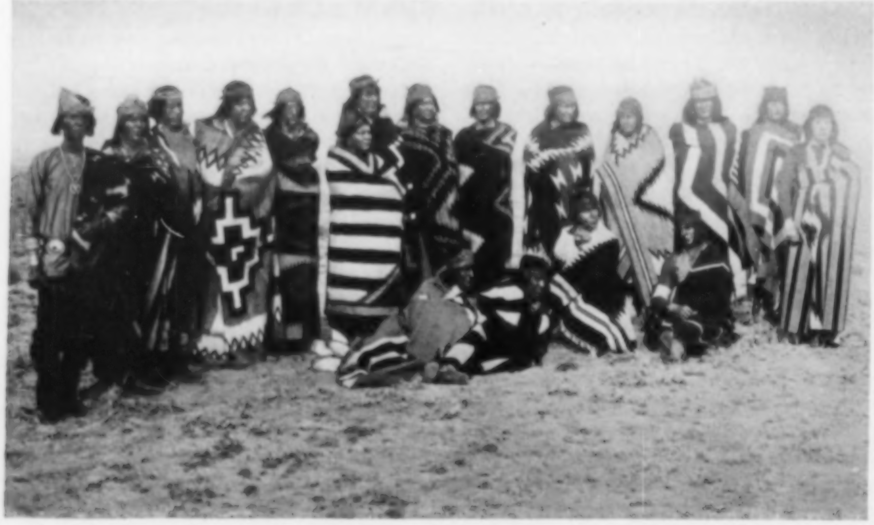
The United States first assumed responsibility for the Navajos in 1848. At that time the tribe was small and made a modest but bloody living by raiding the villages of their Pueblo neighbors, plundering and murdering the Spanish settlers and lifting the hair from all and sundry that had anything the Navajos wanted. Uncle Sam was pretty sick of his wards before he finally figured out what to do with them. Between 1848 and 1863, the Navajos and the United States signed countless treaties, most of which turned out to be just scraps of paper and none of which stopped the depredations. Meanwhile, the squaws had continued to weave rugs, using the wool from their own sheep, and making their own dyes out of native materials. By boiling leaves and twigs of the aromatic sumac for half a day and adding yellow ocher steeped in boiling gum from the pinion tree they obtained a never-fading blue-black. Native alum and the leaves of the rabbit brush gave them other colors.

In 1863 the White Fathers in Washington decided that the marauding of the Navajos would have to stop. So, in an effort to round them up and keep them in one place they offered the Indians tillable land in the Bosque Rodondo in eastern New Mexico where they could make a comfortable living. But the Navajos would have none of it, and kept right on making life miserable for everyone within 40 miles of them. Mildly desperate by this time, Uncle Sam turned over the job of subduing the tribe to Kit Carson, who headed the toughest band of straight shooting hombres in seven states. Carson's orders were to do the job, no matter how. "Kill off their sheep," he was told. "Kill off their horses and cattle and goats. And don't come back until you've rounded up the whole bunch—men, women, and children."

Old Kit executed that assignment to the letter. He rode into the Navajo country shooting at anything that poked up its head. Winter was coming on, and the first thing the Indians knew they were looking a blizzard in the face with not a thing to eat in the hogan. The next thing they knew they were roosting over in Bosque Rodondo trying to make farmers out of themselves and not doing any too well at it. For four years they were held at Bosque Rodondo, four bitter years of hardship and discouragement. They never could learn to farm; and the squaws had no heart and very little wool for weaving. To make their woe complete, their ancient foes, the Comanches, took advantage of their nearness to swoop down at every opportunity. After four years of this, the Government threw up its hands and quit. Rancho Rodondo was a costly experiment for the Navajo tribe; and only some 7,000 Indians with about 4,000 mangy looking sheep got back to their old reservation.

Once more the Navajo women hung their handmade looms from the limbs of trees and began weaving rugs. But things had changed. During their absence the railroad had come through on its way to California, and along with it the riffraff of a frontier. Among them were hard-drinking adventurers and keen-eyed traders, shrewd and domineering, who thought they saw in the Navajo weavers a golden opportunity. One of them was a certain lantern-jawed telegraph operator who ogled the rug business. He it was who introduced the Navajo women to modern dyes that would produce, in the twinkling of an eye, colors that had formerly taken days to prepare. He showed them how to use cotton warp instead of the hard-twisted wool threads. The rugs turned out under this system were garish and fuzzy and poorly woven; but the new order called for speed. The operator set himself up in business in Gallup, N. Mex., circularized a long list of buyers in the East, and peddled a great many rugs. But they were so inferior that orders soon fell off, and gradually the Navajos settled back into their old way of weaving.

The Navajos are great experimenters and open to suggestion. Some years ago a trader persuaded the weavers in his territory to spin and clean their wool more carefully and to stick to quiet but effective combinations of black, white, gray, and tan. As a result we have, from a district on the east side of Chuskai Mountain, the



NAVAJO BRAVES

Navajo textiles were originally of finer weave than they are now and were made to be worn or used as blankets. The demand for them created by the white man led to the present coarser-woven rugs. The plain-striped ones shown here are chiefs' blankets.

famous Two Gray Hills rug. The weavers took the designs suggested by the trader and elaborated them until they bore no close resemblance to any other textile forms. This is typically Navajo—to evolve something peculiarly his own from an alien idea. Chin Lee, another famous blanket, contains a greater variety of colors and is known to be thoroughly and honestly woven. For that matter, virtually all the rugs produced by the Navajos today are of good quality and well made. In recent years the United Indian Traders Association has set a standard to be used in advertising and selling Navajo rugs. The requirements are: "Materials used shall be virgin wool or virgin Angora wool, hand-washed, hand-carded, hand-dyed; the warp shall be all wool and hand-spun; the woof shall be all wool and hand-spun; and the blanket shall be hand-woven by an Indian."

The early, simple style of Navajo blanket previously mentioned led to more complex designs in what is known as the "chief blanket." This was made in two sizes: a small one for women that would leave arms and legs free for household tasks, and one for men big enough to wrap around the entire body. A distinctive feature of the chief blanket (it was made for general use, not chiefs) was that the warp followed the shortest dimension. In other words, it was greater in width than in length. This was a characteristic of the old Pueblo weaving. The Pueblo shawl of today, seen on ceremonial occasions, whether of wool or of cotton, is woven like that.

Navajo weavers didn't stop with stripes. They went on in their experimenting to diamonds and lozenges—the stripes remaining as a minor pattern only. Many of the so-called chief blankets were so designed that when the corners were folded and met at the center the motif formed would be the same as the central figure. But no matter how elaborate, the designs, with few exceptions, are based on simple forms—stripes, zigzags, squares, diamonds, crosses, and chevrons. While these are used by the Navajo weavers for their decorative value, white rug buyers insist on reading symbolism into the formers' creations. Gladys A. Reichard, who went to live with the Navajos to learn their art of weaving, says there is nothing to it. She found that their names for patterns and symbols are quite matter of fact. For example, in her book, *Navajo Shepherd and Weaver*, she reports that their expression for a square is "like a card," a diamond is "big star," and a Roman cross is "sticks crossing each other."

The Navajo tribal religion is symbolized by sand paintings. These are the visual representations of the chants sung by the medicine men, and only medicine men know how to make them. They are executed on the floor of the hogan or ceremonial room, are merely a part of the ceremony, and are destroyed in the course of the ritual. The Navajos believe that the power of their sacred symbols will "wear out" if reproduced overmuch. Hence it would not be natural for them to use them in a commercial product. Some weavers do put them into their designs, but change them slightly to salve their consciences.

Like any other creative artist, the Navajo weaver gets her designs from all around her. A few years ago there appeared at one of the trading posts a rug across which was emblazoned in shaky letters the work Mentholatum. Another bobbed up bearing the letters Arbuck, and it wasn't hard to figure out that the weaver had started in to publicize Arbuckle coffee but couldn't finish the job for want of room. What if it is a name on a soap wrapper or a coffee trade mark! It was the copying of commercial matter such as this that led to Navajo rugs with borders. Of course, the devout Navajo believes that a worker should not "weave herself in," and therefore leaves a gap somewhere in the border. Ceremonial sand paintings are usually bordered, too, but there is generally an opening to "let the spirit out." But taboos break down. Many weavers make their borders solid. The Navajos are daring. One tries a design that is taboo, and if nothing happens to her, others follow suit.

The Navajos use several different kinds of weave. For instance, the saddle blanket, which is for their own use, is woven differently and the designs are not the same as those usually seen in rugs. The Navajo Indian, buck and squaw alike, is a natural horseback rider. For sheer beauty and grace and racing thrills, no turf event can surpass the race in which only Navajo women compete and which is held each year at the Indian Ceremonial at Gallup. This is no humped-over bunch of undersized jockeys bobbing up and down with the horses. Instead, you see the bronzed figures of natural horsewomen, each one a part of her mount. Down the stretch they come with a thunder of hoofs, riding those nags for blood. And if there is anything in your veins besides water, your heart will sing at the wild beauty of the scene. Beneath the saddle on each of these horses is a Navajo blanket woven for that purpose. It is either plain gray or white or is decorated with some simple design such as horizontal stripes. At each corner is a yarn tassel. Out on the reservation, a saddle blanket can be bought for three or four dollars. Many rug buyers do not know that these small pieces, made for home consumption, are more like the old classic weaves than the ordinary rug.

It is not hard to tell a genuine Navajo rug from the machine-made product. The pattern of a Navajo rug is always irregular. That is, the diamonds or squares or other motifs will not be of the same size. A squaw cannot work with uniformity because she has to jump up repeatedly to hunt a mother for a stray lamb or to attend to her household, and when she gets back she most likely has forgotten how many pieces of red yarn she was using for a certain shape. The rugs, fresh from the reservation, have a distinctive though not unpleasant smell. It is a mingled odor of smoke and cedar boughs and of something cooking over an open wood fire. To those who know the Navajo country, it brings to mind the picture of a desolate land sweeping away to blue mountains, the vista of a wide expanse filled with unbelievable color and peopled by a stern-faced tribe that asks only to be left alone. Once upon a time a lordly limousine drew up before a display of Navajo rugs in a store window. The window was tightly boxed in and the rugs had been pent up there for several days. "Are those genuine Navajo rugs?" the lady of the limousine asked. Without replying, the trader led her to a small door in the show window and threw it open. Out of that closed space flowed the unmistakable odor of camp and hogan, telling a story that no words could convey. "Smell 'em, lady," he then remarked tersely, "Smell 'em."

NAVAJO SACHEM

Chief Peschliekine, who is reputed to be the oldest living medicine man in the tribe.

At the end of 1940, according to the survey mentioned earlier in this article, the Navajos owned 37,512 horses. The number, considered too large by the Government, has been appreciably reduced since then; but, even so, nearly every family still has a string of ponies. However, few of the tribe ever ride 700 miles to find an Indian trading post to peddle a rug. Seven hundred miles is too far to ride—even for a Navajo!

Camera Shots at Ea of Continental Divid

Ingersoll-Rand

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East Portal

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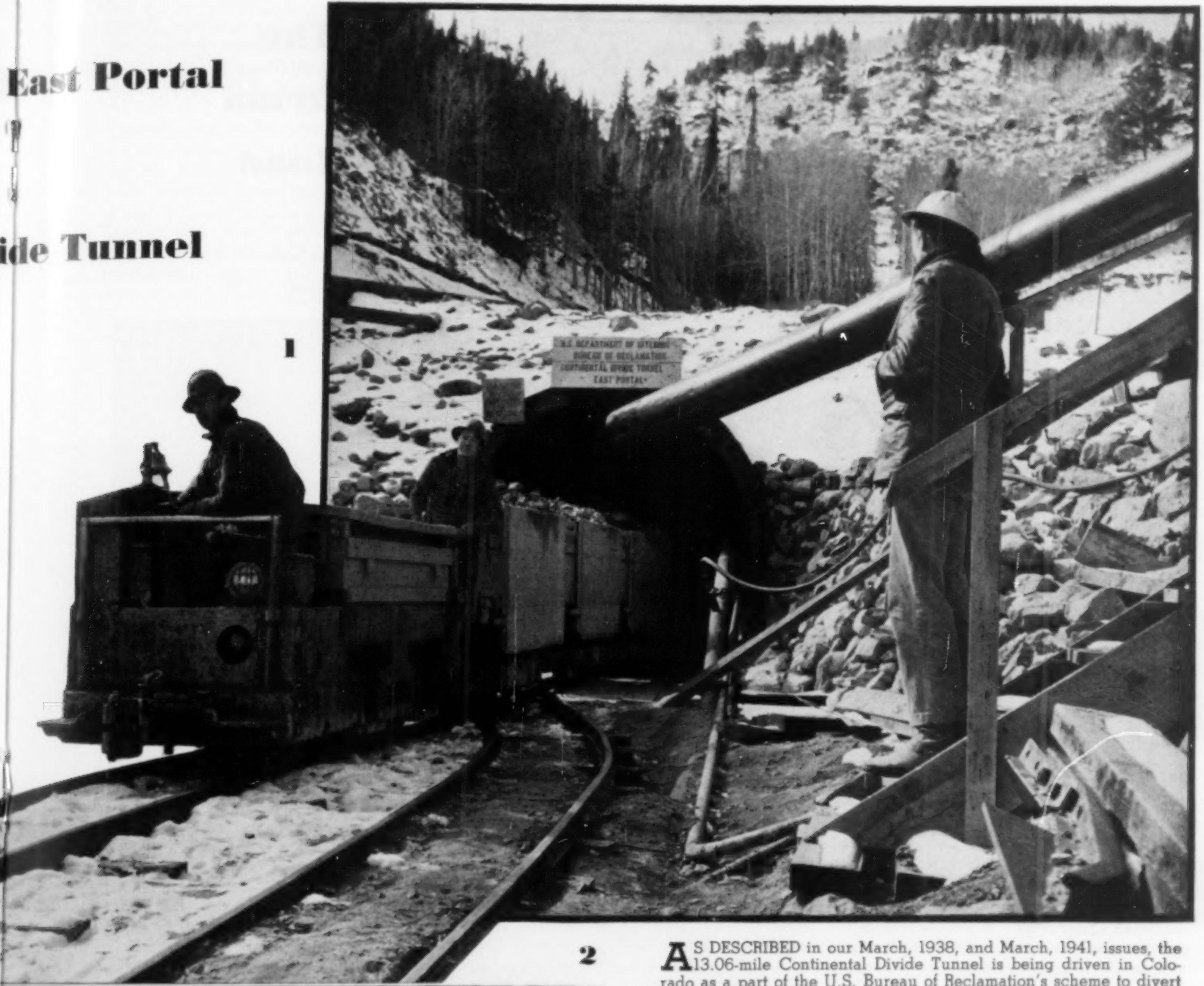

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AS DESCRIBED in our March, 1938, and March, 1941, issues, the 13.06-mile Continental Divide Tunnel is being driven in Colorado as a part of the U.S. Bureau of Reclamation's scheme to divert western-slope water to the eastern side of the range for irrigation. S.S. Magoffin Company, Inc., completed an 8,000-foot section at the eastern end of the bore early in 1941 and is now driving an additional 7,000 feet under a contract let February, 1941. Recent photographs from the job, of which F.R. Purvis is superintendent, are shown here.

1—A muck train emerges from the portal as Tunnel Superintendent Frank Merrick watches from the steps at the right. The portal is a new one, 300 feet of the original approach cut having been put under cover to prevent blocking by small slides of rock down the steep slopes and by drifting snow in winter. In addition to a motorman, each train carries a brakeman to attend switches and to do the signaling. His presence has speeded up train service and reduced the accident hazard.

2—One of the five DA-35 drifters mounted on the drill carriage eats into the rock face.

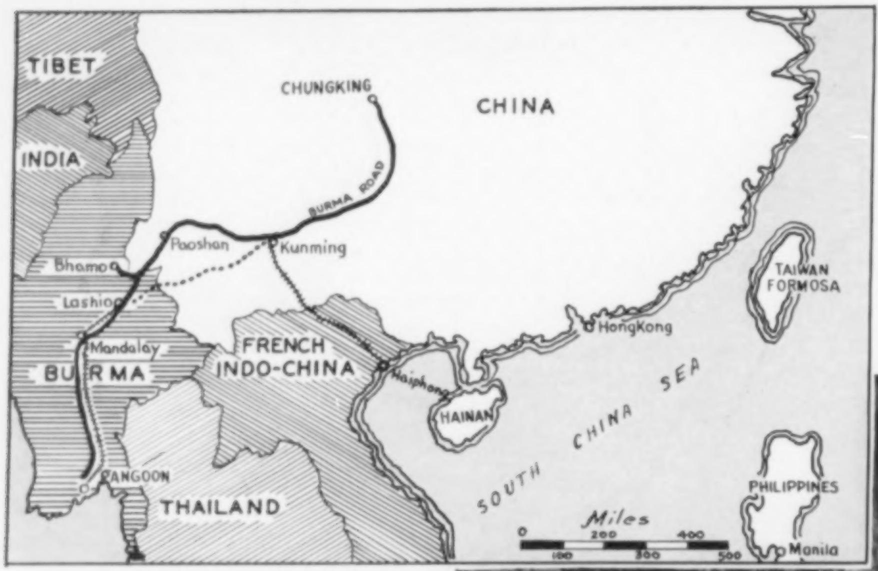
3—The Jackbits used for drilling are now changed at the heading, and steel no longer has to be transported in and out of the bore, as was formerly done. The shank end of the Jackrod is held in a special fixture mounted on the steel car, which is stationed just behind the drill carriage. Four sizes of sharp bits are transported into the tunnel in steel boxes, one of which is shown at the left.

4—An average of 850 bits daily are hot-milled by two men. In the foreground is a Jackmill and beyond it is a Jackfurnace.

5—An automatic block system has just been installed to expedite train service and promote safety. Red lights denote traffic in a block: green lights indicate a clear track. The lights are controlled by electric eyes. A beam of light shines from a box on one tunnel wall, and across from it are tubes for amplifying the impulse to operate relays that change the lights. A man can pass without closing the block, as his body does not break the beam long enough to operate the mechanism.

The Burma Road

Photos by Harold C. Davis



ROUTE OF THE ROAD

Supplies are carried by rail from Rangoon to Lashio, thence to Kunming over the 627-mile Burma Road. Trucking costs over the latter stretch have been averaging 27 cents per ton-mile. Upon completion of the Lashio-Kunming Railroad, indicated by the dotted line, the cost of moving freight will be around 2.4 cents. The rail line through Indo-China is now inoperative.

ONE OF THE MANY BRIDGES

The suspension bridge shown crosses the Salween River. It sways in the wind, but has carried thousands of trucks without mishap. Only one truck at a time is allowed to move over most of the Burma Road bridges.

A SNAKY trail, virtually unused for centuries, has for some months constituted one of China's principal life lines. It is the Burma Road, which weaves and twists its way between Lashio, Burma, and Kunming, in the Yunnan Province of China. It is a vital link in the transport route from the Burmese seaport of Rangoon to China's wartime capital, Chungking. The Burma Road is something of a surveyor's nightmare, a serpentine gash in the landscape that dips and climbs in turn to follow the convolutions of mountain ranges cut athwart by deep ravines. For half its 726-mile length it is a 1-way road, and elsewhere it is seldom wider than 16 feet. Its washboard-like surface conspires with its crooked alignment to restrict speed to 18 miles an hour. More than 1,300 trucks have plunged off its unguarded sides, some of them into abysses 1,000 to 7,000 feet deep, and 700 more have been disabled by mishaps attributable to curves or grades.

In the Middle Ages, elephant trains carried over the route precious loads of silk, jade, ivory, and other products of interior China. Then transportation lines were built from the eastern coast line and the mountain thoroughfare was used only by local inhabitants. When Japan invaded North China in the summer of 1937, General Chiang Kai-Shek foresaw the day when his country might need a back-door entrance, and he set about putting the Burma Road in condition for motor traffic. Within a month, the Government of Yunnan Province undertook this work with the aid of a $2,000,000 national appropriation. Political subdivisions through which the line passes were allotted their respective sections for construction, and workers living within eight days' travel on either side of the route were drafted and ordered to bring their own tools and food. By the end of the second month, 200,000 men, women, and children were on the job, and they served without pay.

The tedious and laborious methods employed would seem incredible to an American contractor. With little exception, human muscles were the sole power available. All rock was drilled by hand, and much of it was broken the same way, explosives being used sparingly. Large rocks were hammered into smaller ones to obtain material for surfacing. This was loaded manually into baskets which were carried to placement areas. Hand-carved rock rollers were dragged over the surface to consolidate it; 2,000 culverts were dug; and 300 bridges were built.

After sixteen months, during which accidents, sickness, and Japanese bombs had taken a heavy toll of life, the road was opened to traffic. It was full of hairpin turns; there was no straight stretch longer than a mile; and the elevation varied as much as 7,000 feet in a 10-mile section. Over this difficult travelway, trucks started hauling munitions and supplies that had been unloaded from boats at Rangoon and transported by railway through Mandalay to Lashio. It was a slow, painful process, but a considerable tonnage was moved. The route was not vital at that time, as others were available; but those extending through Chinese territory were gradually cut off by the Japanese, and in June, 1940, those through Indo-China were closed. Much freight was still transported over some of them by smuggling—by bribing Japanese soldiers; but Rangoon became the principal port of entry for China, and the Burma Road was the only remaining dependable link with the outside world. When Great Britain closed the Burma border in July, 1940, China was in deadly peril; but this ban was raised after three months and goods were again hauled over the tortuous highway.

But under Chinese management, the truck caravans were delivering only about 6,000 tons monthly to Kunming, and in January, 1941, General Chiang Kai-Shek appealed to the United States for aid in the form of traffic experts. These were sent, and by April they had succeeded in boosting the freight to 10,000 tons a month. Although a decided improvement, this tonnage represented only one-third of the estimated carrying capacity of the road. When lend-lease goods shipped from the United States continued to pile up at Rangoon and Lashio, American officials dispatched three men to China to see what was the matter. They were Daniel Arnstein, chairman of the board of directors of the Yellow Products Corporation and head of the New York Terminal Cab Company; Harold Davis, vice-president of the Manhattan Mutual Automobile Casualty Company; and Marco Hellman of the Wells Fargo Bank. Arnstein, who was driving a Chicago taxicab when he was eighteen years old, now operates 7,000 cabs in New York and owns 8,000 trucks.

The trio flew across the Pacific Ocean and on to Chungking, where they had an audience with General Chiang Kai-Shek who gave them authority to proceed with an investigation. They didn't have to look far to spot some of the trouble. Only 1,407 of the 2,887 government trucks could be used. Most of them were too light for the service, and virtually no attention was being given to lubrication and repairs. Few spare parts were on hand for putting broken-down cars in order; shop facilities and machinery were crude and inadequate; and the Chinese mechanics were unskilled. Trucks were improperly loaded, the usual system being to crowd everything forward where the front springs took most of the weight, while the rear of the bodies was often reserved for private freight and passengers. To this graft the drivers added the returns from selling gasoline which they siphoned out of the truck tanks.

The vehicles traveled in convoys, had no definite schedule, and spent from ten to fifteen days on the road with no one knowing just where they were until they arrived at their destination. Seven different agencies of the Chinese government had a hand in the transport organization, and three others were concerned with highway repairs. The customs office at the Burma-Chinese border closed every night at 6 p.m., and trucks arriving after that hour laid over until morning. Similarly, at the 1-way road section trucks could proceed from only one end at a time.

Arnstein and his companions spent eighteen days studying the different angles of the snarl, including a trip over the road in an automobile. That done they flew to Rangoon and compiled a report which, in its boiled-down form, comprised 35 typed pages. They flew back to Chungking, presented their recommendations to Chiang Kai-Shek, and received his assurance that they would be carried out. As a result of their survey, 4,500 new American trucks have been shipped, 35 American mechanics are training the Chinese shopmen in car maintenance and repairs, and American oil refineries have sent 10,000 barrels of asphalt with which to pave certain sections of the road. According to last accounts, between 15,000 and 20,000 tons of freight are moving over the road monthly.

Meanwhile, work has been resumed on the proposed Yunnan-Burma Railroad between Lashio and Kunming. The British built the Rangoon-Mandalay-Lashio line, completing it in 1902. The connecting link, which will be 200 miles shorter than the Burma Road, was started on Christmas Day, 1938, by the Chinese; but progress on it was slow until American technicians arrived on the scene last September. The United States is providing $15,000,000 for the project, with the agreement that China is to furnish the labor. It is expected that 250,000 coolies will be employed on the job.

One of the chief obstacles to be overcome is malaria. This febrile disease is prevalent in the valleys through which the railroad will be run, and the Chinese are in such terror of it that few of them will venture out of the hills. The germ is carried by a small black mosquito, and this insect must be brought under control if the rail line is to go through. Towards this end, the United States is sending $500,000 worth of medical supplies and doctors who will direct Chinese physicians in obliterating the pest.

If all goes well, the railroad will be ready for service in the spring of 1943: under American guidance, it may be opened even sooner. It will serve to augment the flow of munitions and other vital war materials into free China. Meanwhile, traffic over the Burma Road is being steadily stepped up. When more trucks are delivered and the mechanical and supervisory organizations are brought up to the standards set, it is expected that a continual stream of trucks, carrying as much as 120,000 tons of freight monthly, will move over the sinuous mountain highway day and night.

BUILDING THE ROAD

It is doubtful if a single mechanical rock drill helped in reconstructing the Burma Road. Coolies swung hammers on chisels to gouge away the rock, even explosives being used sparingly. Blacksmith shops were equipped with forges made of oil drums and blown with hand-operated bellows.

River Channel Tailored to Avert Washouts

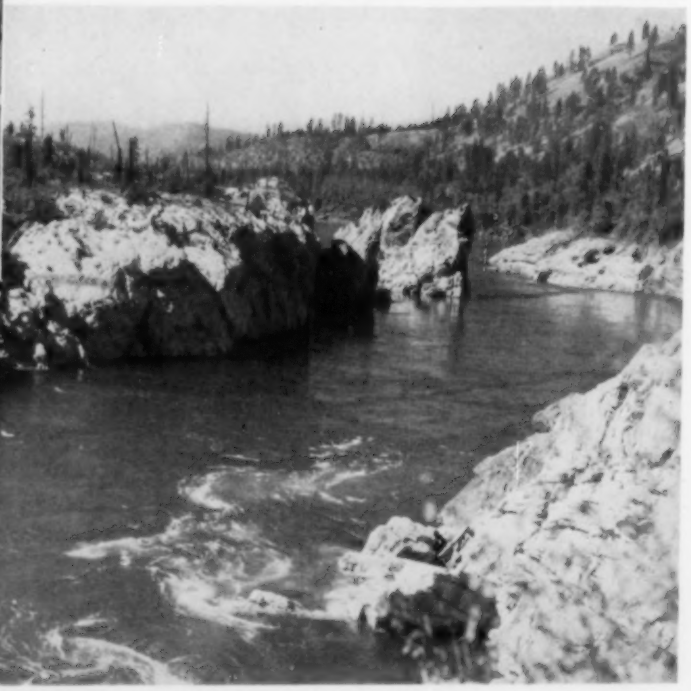
THE Little Dalles, located in Stevens County, Washington, and about 15½ miles below the Canadian boundary, consist of a solid limestone formation through which the Columbia River has for ages past cut a channel which, at low water, is less than 200 feet wide at the narrow points and more than 200 feet deep. The restricted section persists for a distance of approximately 2,500 linear feet. The combination of very rough walls and a confined, irregular passageway results in a high frictional loss throughout this stretch of the river.

The Great Northern Railroad parallels the Columbia for about 37 miles below the International Boundary. Between the latter and the head of the Little Dalles the track embankments have been damaged to some extent by floodwaters of 450,000 second-feet under natural flow conditions. Therefore, under backwater conditions, created by impounding the waters above the Grand Coulee Dam built across the Columbia, the flood stage in the case of a similar flow would be increased and would submerge and damage a greater length of the roadbed unless changes were made in the channel.

If it were possible with floodwaters of 400,000 second-feet and with maximum reservoir elevation to restore the natural-flow stage where the railroad parallels the river above the Little Dalles, abnormal backwater levels in flood seasons would be eliminated both along the railway and at the Canadian border. With this in mind, a location was sought in the Little Dalles

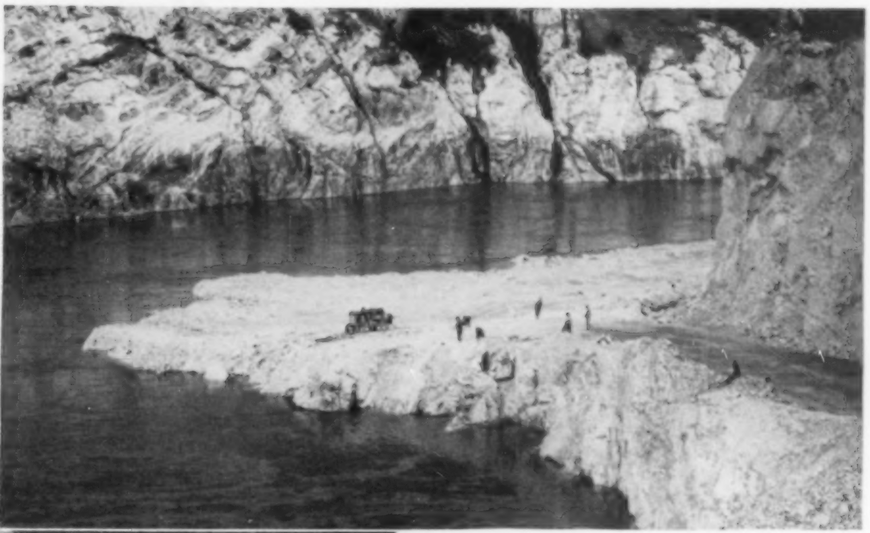
FINAL LARGE BLAST

The four small pictures angling up toward the right show successive stages in the detonation of a blast that broke 50,000 cubic yards of rock.



BEFORE AND AFTER

At the right is a section of the restricted channel which, in places, was less than 200 feet wide and 200 feet deep. The two pictures on the opposite page show how it has been broadened to reduce friction and to lower the level of the water during flood periods. Approximately 275,000 cubic yards of rock was removed from a stretch 2,500 feet long.



where improvements, not involving a prohibitive amount of excavating, would effectually reduce channel friction and high-discharge backwater. The enlargement of the channel would, at the same time, remove the likelihood of claims by the railroad company against the Government for damages caused by high water resulting from backwater. Experiments with models at the Denver Office of the U.S. Bureau of Reclamation showed that the economical limit of the enlargement work would involve the excavation of some 275,000 cubic yards of rock, based on preliminary surveys.

The channel-improvement project is now completed. After the Grand Coulee Reservoir is in operation it will, during high-water periods, insure a water surface above the Little Dalles actually lower than that experienced previously under natural-flow conditions with even greater discharges. Backwater levels at the International Boundary will be lower at floods exceeding 400,000 second-feet, thus preventing damage to existing improvements in Canada, including the Town of Trail. According to records for the past 27 years, a flow of 400,000 second-feet or more occurs on an average once in five years: on the basis of the 82-year record available at The Dalles, a city in Oregon, such a flood is likely to happen once in about three years.

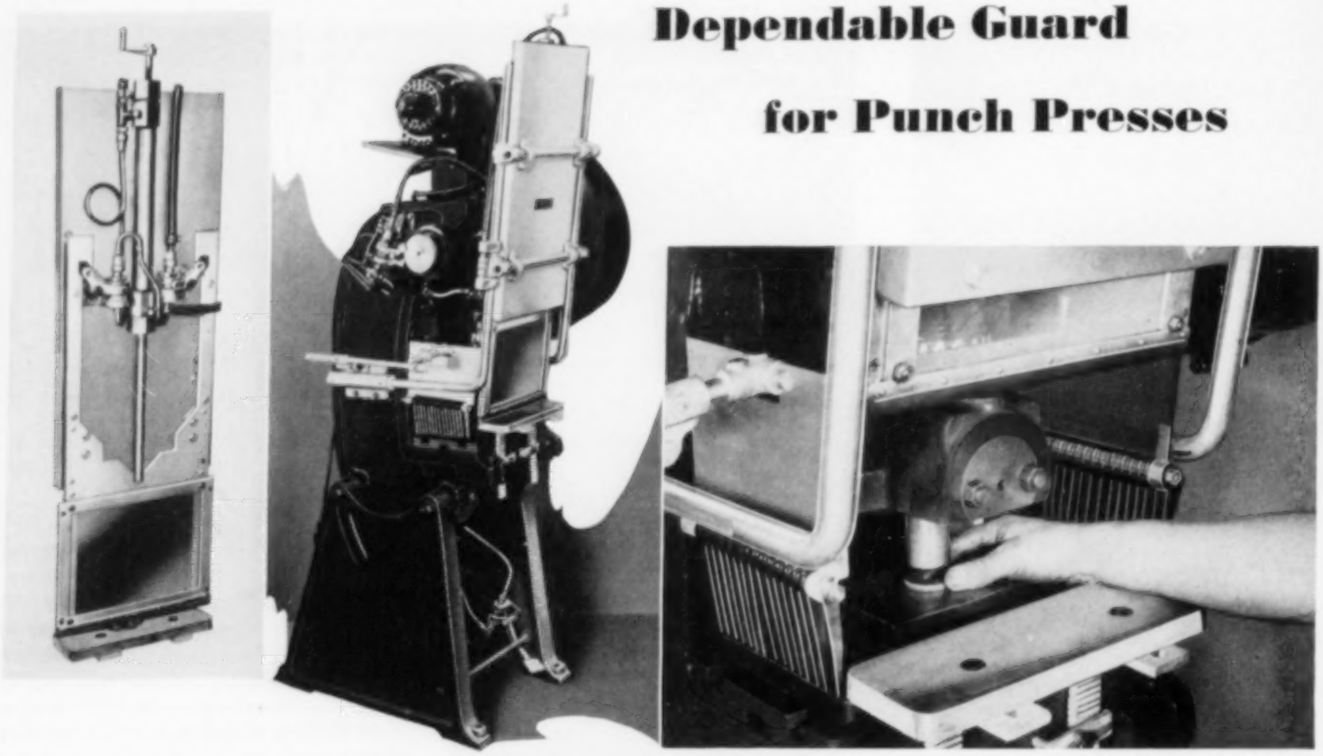
The foregoing explanation of the reason for the improvements that have been made at the Little Dalles and of the benefits that are expected from them was given by F. A. Banks, supervising engineer for the U.S. Bureau of Reclamation at Grand Coulee Dam. The work was done by Max J. Kuney, a Spokane, Wash., contractor, under a $249,000 contract which was awarded him as low bidder and called for the removal of rock in the area concerned down to the approximate level of the former normal water line. The operations were carried on last winter and, because the Columbia starts rising about April 5, it was specified that they be completed within 115 days from November 25, 1940, the date the contract was let. Before actual work could be undertaken, accommodations for workmen, shops, storehouses, etc., had to be constructed. Although the job was to be a short one, a modern camp with hot and cold water, shower baths, bunkhouses, and a cookhouse was set up. The average number employed was 85, and the maximum 100.

The work called for lowering the rock surface throughout the strip involved from Elevation 1,300 to approximately 1,255. This required a cut averaging between 45 and 50 feet in depth, and the job was laid out for the removal of the rock in two lifts. The conditions were favorable to the utilization of wagon drills for the deep drilling, and the contractor employed three Ingersoll-Rand X-71 drifters on FM-2 mountings and using 1¼-inch hollow, round steel and Type 2 Jackbits. At locations where wagon drills could not operate, drilling was done with Ingersoll-Rand JA-55 Jackhamers using 1-inch hexagon steel and Type 1 Jackbits. Compressed air for all the drilling equipment was supplied by two I-R oil-engine-driven portables, a Model D-500 and a Model 315-A.

The first lift was to remove the rock down to Elevation 1,282, a cut averaging 18 feet. Because of the irregular surface it was difficult to set up the wagon drills in many places, and wooden staging was erected to move them as desired. In many instances the actual drilling was done from the staging, and this proved to be a satisfactory method of overcoming the uneven terrain. In order that a fairly level surface might be left from which to start the second lift, some ot the holes for the first lift had to be drilled to a depth of 36 feet. The broken rock was loaded into Mack and Euclid 12-yard trucks by two Northwest 2½-yard shovels.

Drilling was started on January 3, and all channel excavating was completed by April 1. In addition to this work, the contract called for the drilling and removal of several thousand cubic yards of riprap and its haulage to a specified site along the river bank. These operations were concluded on April 26. During the course of the contract, 37,031 feet of wagon-drill holes and 22,612 feet of Jackhamer holes were drilled, and the compressors operated 2,307 hours. Approximately twelve carloads of explosives were consumed in blasting. The shovels worked a total of 2,190 machine-hours and handled 43,310 truckloads of broken material.

Dependable Guard for Punch Presses



COMPLETE SET-UP

At the left, center, is a punch press with the Allsafe Airgard in place and with the die chamber closed but in full view of the operator. The cam-actuated valve that keeps the gate shut when the press plunger is in motion is on the side of the machine directly below the motor. Mounted on the back of the guard is the double-acting cylinder (left) which controls the gate. Any obstruction that prevents the latter from closing properly, or any failure of the air supply, will keep the press at a standstill. At the right is a close-up of the die chamber of an Airgard-equipped machine showing the wing guards that protect the hands when strip or sheet blanking. They are made to swing and adapt themselves to any work of this kind for which the press is suitable. To provide access for die-changing, the gate is raised on its upright guide rods by hand. This automatically cuts off the air supply and enables the die setter to go about his job with absolute safety because the machine is inoperative when in that condition.

IN THE Allsafe Airgard the manufacturer seems to have provided against every possible hazard in running punch presses, which normally are a fruitful source of accidents. In addition to being a safety device, it operates the press, and is said to be suitable for every make and type of these machines. To use the language of the American Allsafe Company, Inc., it goes on a press like an outboard motor on a rowboat. Other than a few minor variations, the essential features remain the same regardless of the size of the machine.

One of our illustrations shows a complete installation with the gate to the die space closed. In the gate is a window of clear, unbreakable Lucite, and at the bottom is a Neoprene bumper that serves as a cushion and prevents hand injuries. The gate can be set for any height of travel within its limits, or it can be fixed in any desired position for such work as strip feeding, blanking, etc., for which are provided swinging side guards that envelop the die clamps and keep the operator's fingers out of harm's way. Bar stock can be fed safely by hand into the front of the press by building up its bolster with parts provided for that purpose.

Operation of the Airgard is effected by means of compressed air. Slight pressure of the foot on a pedal causes a stainless-steel sleeve valve to admit air to a double-acting, variable-stroke cylinder that is cushioned at both ends. The latter controls the gate, which closes fast but without shock, and in closing actuates two positively opened and closed valves in series, thus feeding air through another line to a clutch-operated cylinder on the side of the machine, starting the press plunger. As soon as the latter is in motion, a cam-actuated valve on the end of the crankshaft closes under line pressure and opens all the cylinders and their connecting lines to the atmosphere. This makes sure that the gate will remain down while the plunger is in motion and prevents injury from faulty or repeat strokes.

For bar feeding, strip or sheet blanking, etc., the gate is kept open anywhere from ½ an inch to its maximum travel of 10 inches until the machine is started in the usual manner by depressing the pedal, when it is brought down to the protective position. Through the medium of a 3-way valve, sustained pressure on the pedal permits either intermittent or continuous operation of the press. The work of die-changing is performed with ease and safety, as it is necessary only to raise the entire guard mechanism on its two upright guide rods. This automatically cuts off the air supply and makes it impossible to run the machine.

As previously mentioned, the Airgard is standard for all presses, the only variations being in the length of the gate and in appurtenant parts. The air lines are of seamless copper tubing coupled to Neoprene hose and can be bent to meet requirements. Air at from 55 to 60 pounds pressure per square inch is used and is furnished by small compressors, such as the I-R Type 30, if a shop is not piped for air. These units are driven by built-in motors of from 1½ to 10 hp., are mounted on vertical or horizontal air receivers from 20x50 to 24x72 inches in size, and have a piston displacement ranging from 7.8 to 54 cfm. A machine of the latter capacity is adequate for seven Airgard-operated-and-protected presses.

One of the advantages claimed for the new safety equipment is that it is not limited in its usefulness and can remain in place when changing over from one to another of the various operations performed by punch presses. If the Airgard is removed, the machine becomes inoperative; when in service, the press never starts until the gate is closed tight or is fixed in position; and the gate cannot be elevated until the machine has come to a dead stop. The device has been approved by New York and Pennsylvania and is said to exceed the requirements of the codes of these and all other states in the Union.

Safety in Tunneling

ALTHOUGH the rate of driving tunnels has been much increased in the past ten years, there has been no decrease in the accident-frequency rate. The worker's chances of being injured or killed are just as great as they were twenty years ago. These are the findings of two investigators for the U.S. Bureau of Mines, Daniel Harrington and S. H. Ash, whose report has just been published as Bulletin 439. The authors express the belief that there will be no great improvement in this respect until the industry comes to the realization that safety in tunneling is as important as are mechanical equipment and men.

In the average tunneling operation, one accident out of every 70 kills a man, and there is one fatal injury for every 460,000 man-hours worked, or for every 1.1 million dollars earned by contractors or invested in projects, or every $400,000 in wages paid to workmen. Despite the generally unchanged condition, certain tunnels have been driven with relative safety, thus demonstrating that accidents can be reduced if proper safeguards are set up. Large projects of this kind are relatively safer than small ones, principally because of better organization and superior equipment, and more accidents occur during the first stages of the operations than later on. It is worthy of note that accidents are less frequent in metal mining than in tunneling, although both involve much the same kind of work. From 30 to 50 per cent of all tunneling accidents result from falls of rock, and these are more frequent at the working face than elsewhere.

Only fragmentary data were available to the investigators, who comment on the scarcity of information on the safety aspects of tunneling contained in descriptive literature covering individual contracts. The authors offer numerous suggestions for improving the situation, the principal ones being: Physical examination of all prospective employees; use of all available protective clothing such as hard hats, hard-toed shoes, etc.; education of employees in safety methods; first-aid-to-the-injured training for all employees; employment of a competent safety director working directly under the operating head of the project; distribution to all employees of safety regulations and strict enforcement of them; holding of regular safety meetings at which nothing else shall be discussed; placing a premium on safety by offering bonuses for its practice; compiling complete accident records; employment of a supervisor or boss for every 25 workmen; exercise of great care in storing, transporting, and using explosives; adequate lighting for all working places; and regular examination of working places by competent inspectors to make certain that no undue hazards exist.

●

Japan's Hari-Kiri

ONE does not have to be an American patriot to diagnose Japan's war effort as hopeless. She has been successful in her initial surprise lunges; but she simply doesn't have the mineral resources that are essential to sustained warfare. At the outbreak of hostilities she was self-sufficient in only copper and chromium of the strategic metals. Her conquests since then have added to her mineral supplies; but she is still deficient in many of them and there is little prospect that she can materially better her position unless she can overpower either Great Britain or the United States.

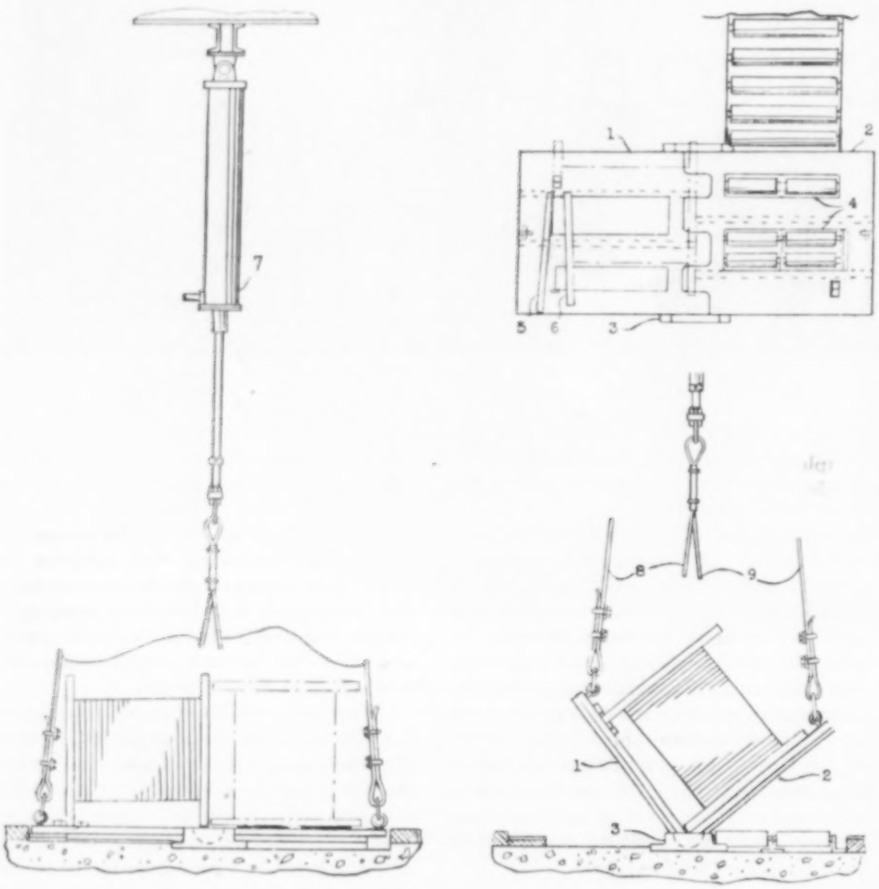
Japan has been mining copper since the sixth century. Formerly she exported considerable quantities; but in recent years she has produced barely enough for her own peacetime needs. Other minerals found in some amounts within her own territory include gold, silver, iron, lead, zinc, pyrites, manganese, tin, mercury, bismuth, tungsten, chromium, and molybdenum. Her iron reserves are inadequate. Although the steel output has been stepped up to new high records, having been tripled since 1930, the production of pig iron has not kept pace with it, and maintenance of the current rate depends upon pig iron and scrap from outside sources. The United States has been the principal provider of these, as 56 per cent of our ferrous exports in 1939 went to Japan. The Nipponese steel industry has relied upon Germany for most of its plant and equipment and has been obliged to import much of the special and alloy steels necessary for aircraft, automobile, and machine-tool manufacture.

Japan has a sizable aluminum industry, but she depends upon imported bauxite ore. She is also short of the coal, hydroelectric power, and coke that this industry requires. In 1939 she imported more aluminum than she produced. In the case of pyrites, all of which goes to make sulphuric acid, Japan is well provided. There is some lead and zinc, but not enough. She has to import nickel, and lacks the technical knowledge to produce metallic nickel from its ores. She was weak in tin when the war broke out, but at present has control of adequate supplies of Malayan ores. For many years she has obtained most of her potash from the Americas, and potash has been rationed since 1939.

Japanese coal deposits are mostly hard to mine and are long distances from industrial centers. In recent years the fuel has cost considerably more in that country than in the United States. Imports have been running around 5,000,000 tons annually. In 1939, Japan produced only about 12 per cent of the petroleum she consumed. She has now gained control of some Dutch oil lands, but most of the wells were rendered inoperative before they changed hands.

Even assuming that Japan overruns lands that can bolster her in raw materials, she still must transport them by sea, and this will become increasingly difficult as Allied naval strength becomes organized and harasses her shipping. On the face of it, all the evidence indicates that the Nipponese war lords cut their country's throat when they elected to take on John Chinaman, Uncle Sam, and John Bull at one time.

Upender for Heavy Objects



STRUCTURAL FEATURES
In the complete assembly of the upending device (left) the reel is shown in normal position on Casting 1. At the bottom, right, it is seen in the raised position and transferred to Casting 2 ready for lowering on to the conveyor. At the top, right, is the plan view of the equipment

ANYONE who has tried to upend a heavy object knows that it can usually be raised to the balance point with a crowbar or rope sling, combined with hard manual labor, but that it is next to impossible with such aids to lower it easily without shock after the balance point is passed. He will therefore appreciate the patented device used in the Kearny, N.J., wire-drawing plant of the Western Electric Company for upending 1,000-pound reels of wire from a rolling position and placing them on a conveyor with the reel axis vertical.

The equipment is shown in detail in the accompanying line drawings in which *1* and *2* are flat castings that are identical in shape and dovetail to form a large hinge with the base member *3* serving as the socket. The conveyor rollers project through openings *4* in the secondary casting, and two guiding strips *5* and *6* welded to the primary casting assist the operator in rolling the reel into position. As the outer edge of its right flange is guided along the center line of rotation of the hinge, the left flange drops into the large opening in the primary casting to prevent further movement.

With the reel in place, castings *1* and *2* are lifted by means of air hoist *7*, which transfers the load from the primary to the secondary casting by the simple expedient of adjusting cable *8* so that it is shorter than cable *9*. Lowering the reel on to the conveyor rolls completes the operation, which is effected by exhausting the air from the hoist. By controlling the air flow—cushioning the action—this is done so gently that nine units have been in service for two years without a single roller failure. The load rating of the latter is a little more than twice the dead weight of the reel.

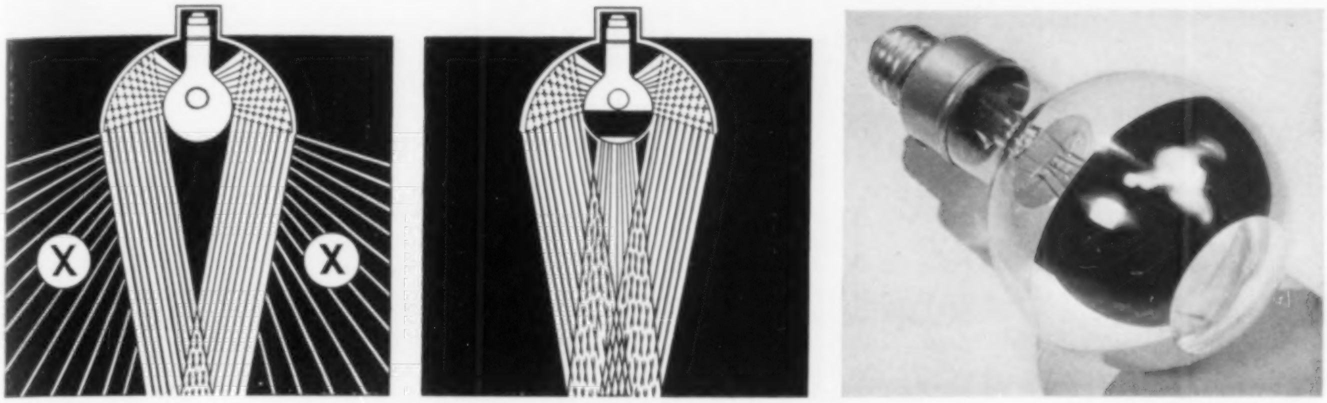
Monitor for Machines to Prevent Overloading

TODAY, when machines are being worked to the limit of their capacities to meet production schedules, there is more reason than ever to avoid overloading and possible breakage. To forestall such a contingency, H. P. Kuehni of the General Electric Company has developed a new type of electromagnetic gauge especially for punch presses, shears, and other machines in which the strain during the operating cycle rises abruptly to the maximum and falls sharply to zero within a very short period.

The instrument consists of a rod, lever arm, and head made up of an armature within two coils. It can be applied to any part of a machine where the stress is equivalent to that on the vital part. When attached it looks like an automobile jack viewed from the side—the rod being the handle, the lever arm the jack, and the head the base. Before work is started, the position of the armature within the coils is adjusted so that a zero reading is registered on a connected instrument. When the machine is put in operation and strain is exerted, the rod pulls down on the lever arm which, in turn, pulls down on a pin in the armature and moves the latter to a new place within the coils. This affects the electromagnetic relationship between the armature and coils in proportion to the strain. The instrument, previously calibrated against known loads, then indicates to the operator the extent of the unknown strain. The gauge can be connected for more than one kind of reading and to give a visible or audible signal when a predetermined amount of strain has been reached.

Glycerin from Microscopic Sea Life

GLYCERIN comes under the head of national-defense products because its greatest outlet is in the manufacture of blasting and other explosives such as dynamite, cordite, etc. Most of the present supply is obtained from a by-product of the soap industry which, among a wide variety of vegetable and animal oils, has used large quantities of whale oil which it is becoming increasingly difficult to procure. The huge mammals, we are told, feed on plankton, a microscopic form of sea life that is approximately 10 per cent glycerin and of which an inexhaustible supply is available. It is reported that Prof. Trevor Kincaid, zoölogist at the University of Washington in Seattle, has experimented with this oily form of marine life and has succeeded in obtaining from it by means of a process developed by him the basic component of nitroglycerin. The problem now engaging his attention is that of equipping fishing vessels for the gathering of the raw material.



COMPARATIVE EFFECTS AND SILVER-RINGED BULB

At the right is the Bullseye-type infrared tungsten lamp that is designed to prevent heat loss by concentrating the beams right into the drying area, as indicated at the center. The left-hand diagram shows what happens with a clear bulb similarly mounted in a convergent beam reflector. The "spilled" heat is indicated by letter X.

Infrared Lamp Concentrates Heat Beams

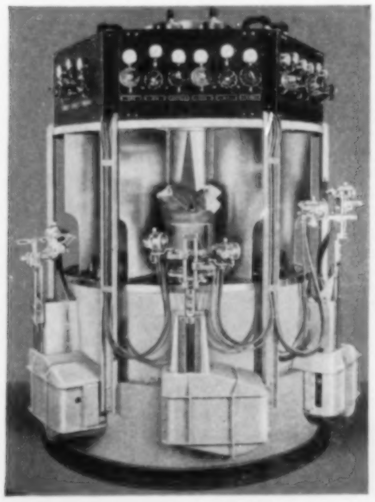
FOR greater efficiency in drying and baking paints, lacquers, enamels, etc., with infrared lamps, the Wabash Appliance Corporation has attacked and, it is claimed, solved the problem of "spilled" or lost heat unavoidable with the clear bulbs now in general use. It points out that an average of 25 per cent of the heat rays given off by them are beyond the control of the reflector, whether it is shaped for parallel, divergent, or convergent beams. To concentrate the latter so that all the radiant heat will do useful work, the company's research engineers have produced a new type of tungsten lamp that calls for no change in reflectors.

The principal feature is a band of pure silver sealed in the bulb. The lining begins just below the focal point of the filament, leaving a clear bull's-eye at the bottom through which the rays are projected without loss, as one of the accompanying diagrams shows. In addition, it has a mechanical strap-in base made heatproof to prevent it from loosening under the terrific temperatures that are developed in infrared tunnel installations. The tungsten lamp is available in the 250-watt size, fits the standard Edison screw socket, and is said to have an average burning life exceeding 5,000 hours.

Metal-Spray Machine Works Automatically

WHAT is said to be the first automatic metallizing machine has been developed and built by the U.S. Galvanizing & Plating Equipment Corporation in collaboration with the Metallizing Engineering Company, Inc. It is designed for spraying aluminum or other corrosion-resistant metals on air-cooled cylinders for airplane engines, but can readily be adapted for coating other work. The unit has six separate stations, each of which is controlled by reducing gears and can be adjusted for varying motions and speeds of operation. The cylinders are loaded at Station 1 and then indexed to Stations 2, 3, 4, and 5, where the metal is applied. At Station 6—the final step in the cycle—the cylinders are inspected and unloaded.

The spray guns are of the Metco power-controlled type and are mounted, usually in twos, so as to move up and down and at different angles to cover every section of the cylinder assembly. They are operated with compressed air at from 60 to 65 pounds pressure per square inch, the air serving not only to atomize the molten metal but also to drive the high-speed turbine in the gun that feeds the metal wire through it at constant speed. Dry, clean air is used, the consumption ranging from 20 to 28 cubic feet per minute. Machines of this design are installed in aircraft and other plants where they are turning out complete cylinder assemblies at the rate of from 30 to 40 an hour. In addition to speed of production, they are said to do the work with a uniformity not possible with hand-held guns.



SPRAYS AUTOMATICALLY

New Process for Making Chlorine Gas

AT THE sixth annual symposium of the Physical and Inorganic Chemistry Division of the American Chemical Society held at the Ohio State University, Prof. Arthur W. Hixson and Dr. Alvan H. Tenney of the department of chemical engineering of Columbia University announced a new process for the making of chlorine gas. The report is of considerable interest at this time from two standpoints—averting of a possible chlorine shortage and conservation of electric power.

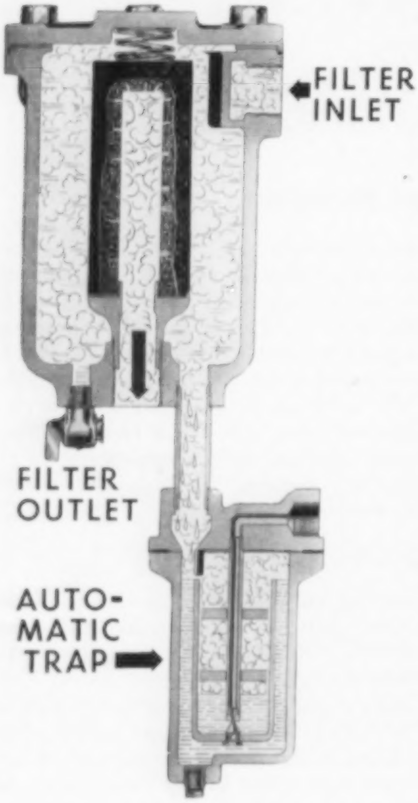
Aside from its many civilian uses, the chemical is needed in the manufacture of synthetic rubber and war gases, for bleaching cotton linters for smokeless powder, and, most important of all, in preparing high-octane fuels for aircraft and the mechanized units of the armed forces. According to *Mineral Trade Notes*, published by the U.S. Bureau of Mines, it is believed that the demand for chlorine in the production of ethyl fluid for high-octane gas exceeds all others, and it has therefore been suggested that the making of premium grades of gasoline for private consumption be abandoned as a chlorine-conservation measure.

By the new process, chlorine gas and salt cake are obtained from salt and sulphur, of which abundant quantities are available. The cost of manufacture is said to be the same as that by the present electrolytic method; but the treatment does not call for the use of electricity. This means that the large blocks of power now required annually by the industry could be diverted to other necessary war work.

Industrial Notes

Of wartime interest is the possible substitution of ground mica for zinc oxide in the making of rubber. Sericite, a talclike hydrous mica, is being tested for use in the manufacture of tires, which requires 60,000 tons or more of zinc oxide annually.

R. P. Adams Company, Inc., makers of filters for compressed-air and other installations, has developed an automatic moisture trap for its Poro-Stone air filters.



The trap is designed to discharge the accumulated oil and, incidentally, water removed from compressed-air lines so as to prevent clogging and to assure the proper working of the filter at all times. In its passage through the filter, the oil and moisture are separated from the air stream by centrifugal action and drop through a vertical slot into the body of the trap in which is suspended an aluminum float that is the only moving part in the whole assembly. As the oil naturally rises to the surface of the water, it reaches the upper level of the open bucket first, overflows, and is continually removed ahead of the water. The Poro-Stone filter tube serves to remove bits of pipe scale, rust, and other foreign matter that would cause trouble in paint sprays, tools, and other pneumatic equipment. It also absorbs small quantities of oil in mist form in which it is too light for centrifugal separation. Claims made for the Poro Stone are maximum air diffusion for effective removal of the solids, ease of cleaning, and life-long service without loss in efficiency. The filters are available for pipe sizes ranging from ⅜ inch to 4 inches and for maximum working pressures of 150 pounds per square inch.

The Hercules Powder Company has announced a process for the production of pine oil from gum turpentine. Pine oil is required in the flotation process for the separation of ore from its gangue and is being consumed in increasing quantities because of the great demand for zinc, lead, copper, molybdenum, and other metals to meet the national-defense program.

Saran is the name of a new thermoplastic material that is being substituted for priority copper in the manufacture of tubing ranging in diameter (outside) from ⅛ to ⅜ inch and with wall thicknesses of 0.03 to 0.062 inch. It is claimed that the tubes will withstand repeated flexing and that test pressures up to 1,500 pounds per square inch have been applied without causing rupture or leakage. The plastic is resistant to moisture, brines, solvents, acids, and alkalis, and can be subjected to temperatures up to 275°F. for short periods. It is a product of the Dow Chemical Company.

By a method based on a process developed at the Massachusetts Institute of Technology, the General Electric Company is surfacing glass so as to destroy its reflectivity. The material being treated is meter-cover glass, which is placed in a 3-foot spherical vacuum chamber along with an evaporator charged with a small amount of fluoride. Each cover is supported in a holder provided with alnico magnets that adhere to the inner wall of the sphere. To destroy the glare, the fluoride film must have an approximate thickness of 1/300,000 inch, and this is controlled by the complete evaporation of a precisely measured-out quantity of fluoride. After the glass has been coated on both sides it is heat-treated to harden the film, which is then made waterproof.

Metal dust, flakes, fine chips, etc., clinging to tools, drills, punches, and dies that have become magnetized through friction or to parts that have been held in magnetic chucks, are apt to cause trouble unless the abrasive particles are removed. The best way to get rid of them quickly is by demagnetization, and for this purpose the Ideal Commutator Dresser Company is offering a new powerful demagnetizer that is light enough so that it can be carried to the work if the latter is too bulky to be carried to it. The part or tool is neutralized by slowly passing it over the magnetic poles and back again until the entire surface has been covered. The unit has a rating of 115 volts, 50-60 cycles (5 amperes), but is available in other voltages and frequencies.

Safety vacuum torches ranging from light- to heavy-duty, wheel-mounted models are the product of Mahr Manufacturing Company, makers of industrial heat equipment. They are designed to burn distillate, kerosene, or fuel oil, which is fed to the nozzle from a 5-, 15-, or 20-gallon tank under vacuum—not pressure, thus eliminating the fire hazard. Any leak in the oil line will admit air and cause the flame to sputter or go out. The patented nozzle has two chambers with openings between them to admit outside air. After being atomized, the fuel is discharged into the first chamber where it is ignited by a piece of burning waste held at the air openings (the torch will not light if flame is held in front of the nozzle). Passing through a choke into the second chamber, the burning vapor draws free air in through the openings, thus effecting complete combustion, it is claimed, and producing a steady, intense, flame that can be adjusted as to length. Compressed air at from 50 to 125 pounds pressure is used; and the torches are suitable for mold and skin drying, ladle heating, and cupola lighting in foundries, for singeing in packing plants —in fact for work requiring direct heat.

ALL-PURPOSE MODEL

This is the largest of the safety vacuum torches showing the straight- and elbow-type nozzles used. It burns from 3 to 20.4 gallons of fuel an hour and with air at 80 pounds pressure consumes from 10 to 46 cfm.

Machines that grow more rubber than nine million trees

A typical example of Goodrich product development

MACHINES like that in the picture will soon become the world's largest rubber plantation — they will give America 34,000,000 more pounds of rubber a year for defense needs — more than could be produced in a year by 9,000,000 rubber trees.

For many products, rubber reclaimed from used tires is even better than the raw product. But wires are imbedded in the tire rim so firmly there has been no way to get them out. So, in reclaiming, the rim section was cut off and wasted, the rubber burned.

A few years ago Goodrich engineers, anticipating the defense need for rubber, set out to stop that waste. After experiments they finally developed the machine in the picture. It slits the rubber down to the wire, all the way around the piece of tire formerly wasted. Then, while the rubber is evenly held by the machine, sharp mechanical fingers reach in, grip the wire, pull it in just the right direction to produce a shearing action, and strip it away from the rubber. The rubber formerly burned is all saved.

In this emergency, B. F. Goodrich has arranged to make the machine available to all rubber reclaiming companies, and from the tires they reclaim every year it can add 34,000,000 pounds to America's vital rubber supply.

Here is a perfect illustration of B. F. Goodrich research. It is constantly at work not only to improve rubber products themselves but also to improve the equipment for making and using rubber — in time of peace or war. *The B. F. Goodrich Co., Industrial Products Division, Akron, Ohio.*

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UNDER ALL OPERATING CONDITIONS

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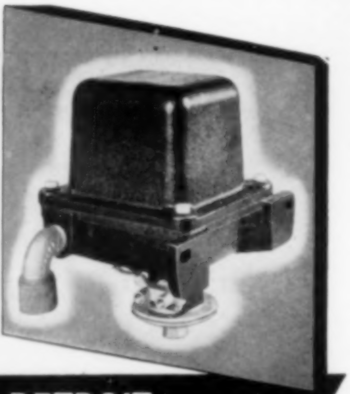

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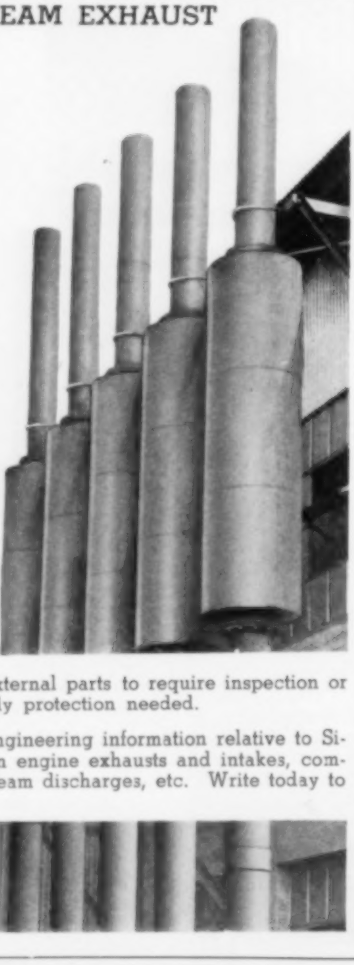
Maxim will gladly supply engineering information relative to Silencers for internal combustion engine exhausts and intakes, compressor and blower intakes, steam discharges, etc. Write today to



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Maintains constant pressure by governing inlet of compressor. Loads and unloads without shock or strain.

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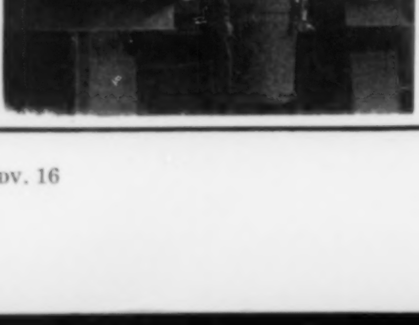

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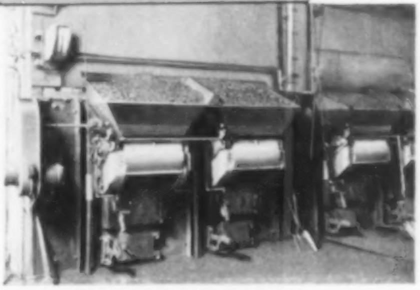
IN THE SINGLE RETORT AND SPREADER FIELD

Here's your Stoker

TYPE E



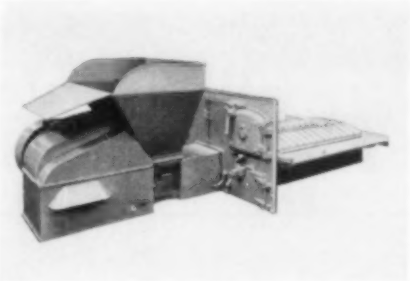
SPREADER

TYPE E A center retort, underfeed stoker designed to burn either coking or non-coking bituminous coals. Applicable to boilers ranging from 150 to 600 rated boiler hp. It is the best known and most widely used of all underfeed stokers and has been the recognized leader in its field for the past quarter century. This C-E Type E Stoker is available with either integral steam piston, electric or hydraulic drive.

SPREADER Combining the advantages of burning fine coal in suspension and coarser particles on a grate, the C-E Spreader Stoker has an unusually wide range of application. It is suitable for boilers ranging from about 150 rated hp up to the largest sizes of stoker fired units. The C-E Spreader Stoker burns all types of both bituminous coal and lignites. It embodies special features of design and construction which make for reliability and efficient performance.

SKELLY The C-E Skelly Stoker is for the range of service from small heating boilers up to units developing 400 hp. It is the outstanding value in the smaller stoker field with many features ordinarily associated with big stoker operation. It is serving factories, laundries, dairies, greenhouses, hotels, warehouses and all kinds of institutions. It is available with either electric or steam drive in three different types: center retort, or side retort, each with moving grates; side retort with stationary grates.

LOW RAM A ram type, underfeed stoker designed to burn either coking or non-coking bituminous coal under boilers rated up to 250 hp. Low an compact, it is especially suitable for low-set water-leg heating boilers where head room and furnace volume are limited. Notable for rugged construction, simplicity of operation and accessibility of all vital parts. Available in center-retort and side retort types.



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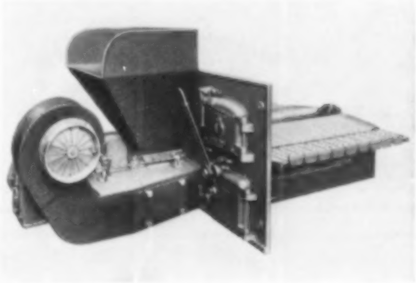

LOW RAM

WHY SAY "Here's your stoker" and point to four of them? Because only *one* stoker will suit *your* needs exactly. Hence the advantage of selecting a stoker from the extensive C-E line. You get *the* stoker best suited to *your* conditions – designed to burn *your* coal – to fit *your* boiler – to operate efficiently under the load conditions at *your* plant.

When C-E engineers offer recommendations to a prospective stoker purchaser they have complete freedom of choice. If, for example, conditions indicate the use of a single-retort underfeed or a spreader stoker they have a complete range of types and sizes to choose from as illustrated and briefly described above.

All four of these stokers are built to the high standards of design and workmanship that distinguish C-E equipment in the field of steam generation. Collectively they are serving hundreds of industrial plants throughout the country. They are establishing records for dependable performance, low operating costs and minimum maintenance which prove them to have been wise investments for their owners.

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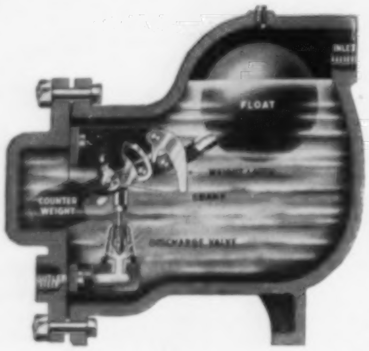
C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



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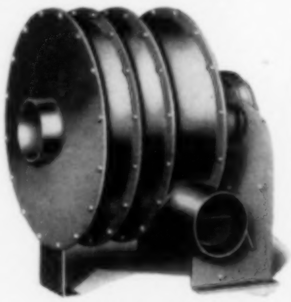

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The unit can be placed wherever most convenient. Flexible pipe connectors are supplied with each unit. No concrete foundation required.

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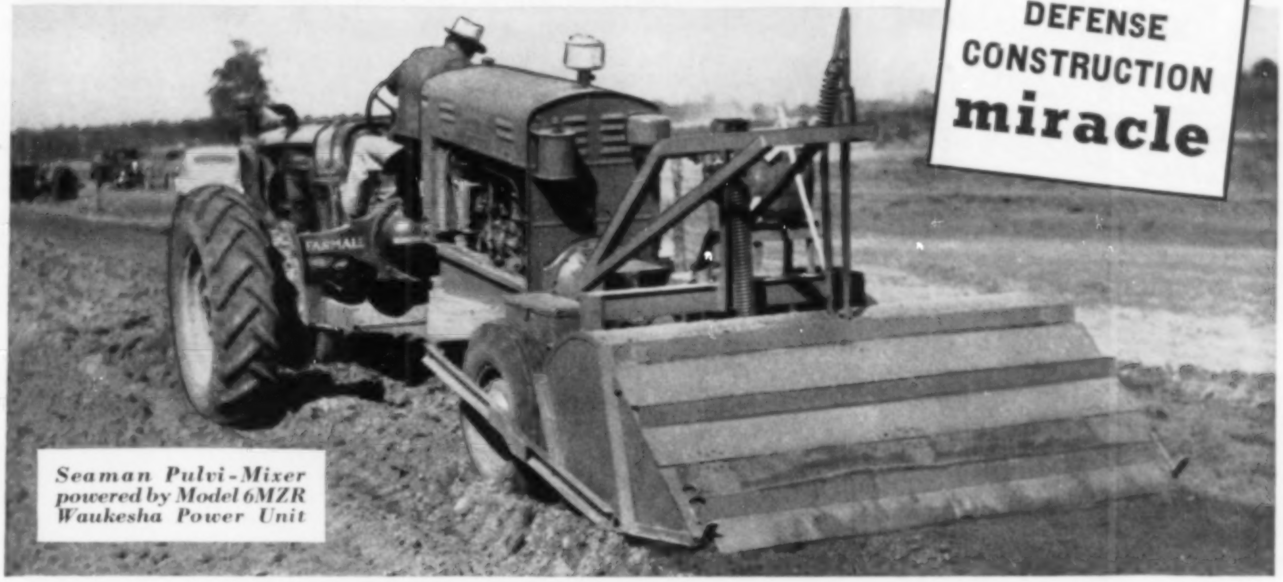

Seaman Pulvi-Mixer powered by Model 6MZR Waukesha Power Unit

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Special machines, like the one shown here, were used by the contractors, D. W. Winkelman & Co. of Syracuse, N. Y. These Waukesha-powered Seaman Pulvi-Mixers mix in 15% Portland cement while pulverizing the soil. Then, after power spraying with water, they mix the water with the cement soil combination.

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MORE POWER FOR DEFENSE

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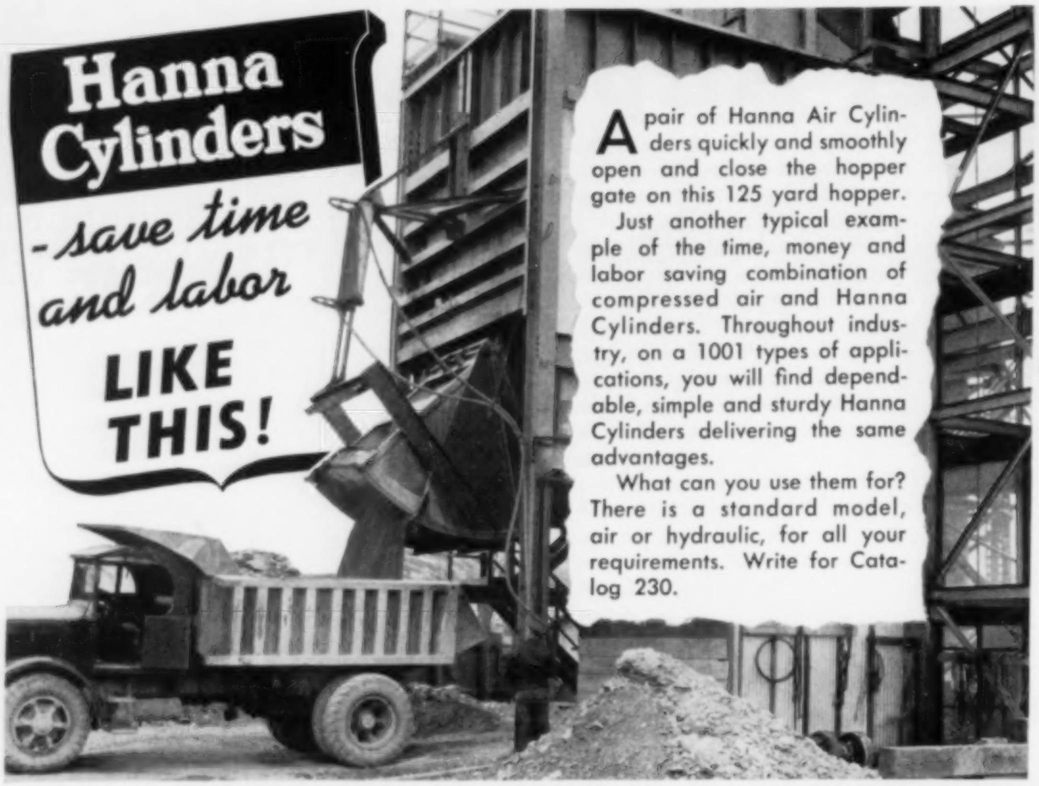

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LIKE THIS!

A pair of Hanna Air Cylinders quickly and smoothly open and close the hopper gate on this 125 yard hopper.

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GREATER PNEUMATIC EFFICIENCY

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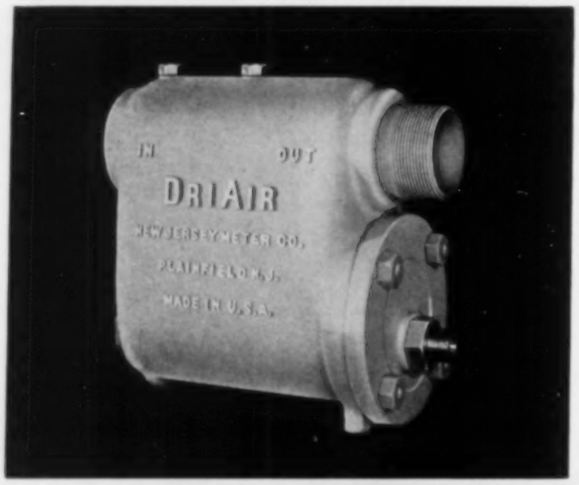
A COMPLETE SELF-CONTAINED UNIT

● DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

Write for Bulletin DA which fully describes the construction and operation of the DriAir.



DriAir may be suspended from overhead piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

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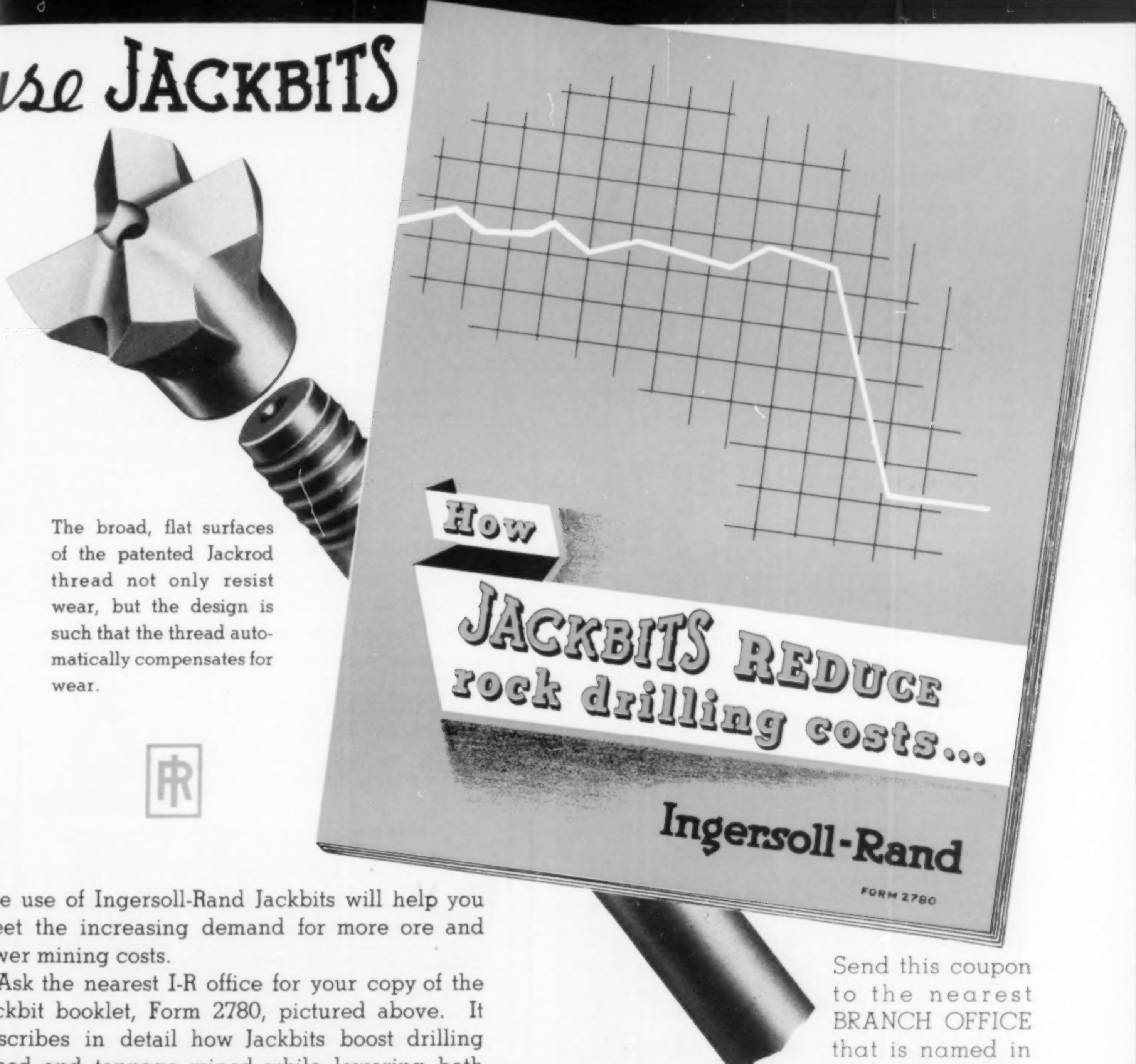
use JACKBITS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For Replacement of Packings and Gaskets

GARLOCK packings and gaskets give long, dependable performance month after month because of our *quality-controlled* method of manufacture.

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Garlock Lattice - Braid Packing is unusually flexible. Its unique structural design imparts semi - automatic pressure action. Available in several styles for various types of service.

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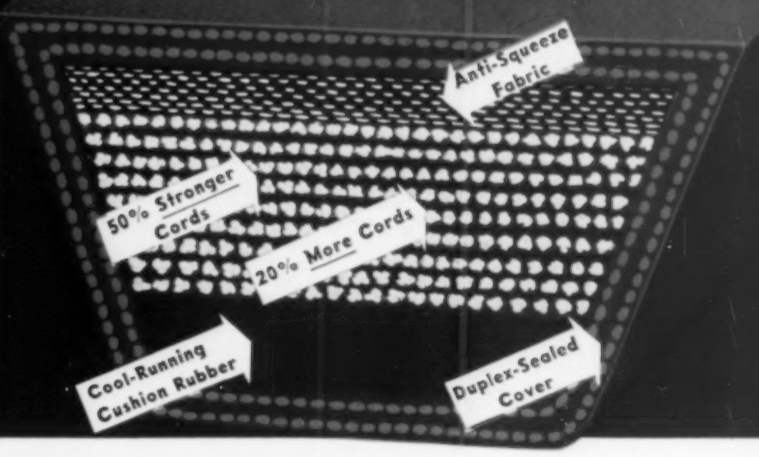
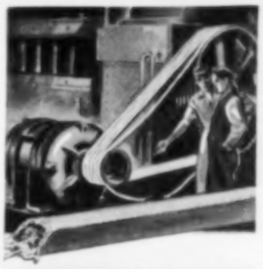
WITH NEW TEXROPE* SUPER-7

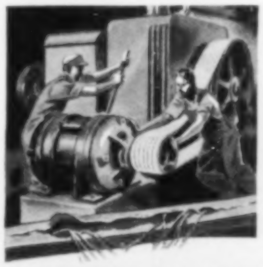
1. **50% STRONGER CORDS!** Sensational new Flexon process makes cords 50% stronger than even those in former great Texrope belts.
2. **20% MORE CORDS!** Count them! You get 20% more of these tough, extra pulling power cords in every Texrope Super-7.
3. **INCREASED LIFE!** Cords float on amazing cool-running cushion rubber that absorbs shock . . . actually increases belt life phenomenally.
4. **EXTRA PROTECTION!** Exclusive duplex-sealed cover protects pulling cords against dirt, grit, moisture, and other adverse elements.





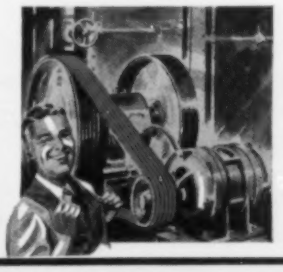
LOOK OUT FOR DANGER

in belts with stiff, unpliable cords! Such belts *look* strong . . . but actually they buckle over sheaves, build up excessive heat that attacks pulling cords. Result: Belt failure far sooner than you expect it.



WARNING SIGN!

Sagging, slipping belts mean too much stretch not backed up by balanced cord strength. Motor must be pulled back often to take up slack. Result: When stretch limit is reached belt breaks under tension.



SUPER-7 TEXROPE BELTS

are made by amazing Flexon process that *combines* flexibility with low stretch . . . great strength. Cords float on cool-running, shock absorbing cushion rubber. Result: *true* strength . . . *true* pulling power . . . *true* endurance.

TO WIN the war—America needs top efficiency in the use of its power . . .

That's why Texrope Super-7 V-belts have a double-barreled value today. For here's a line of V-belts that has been designed and built to give you increased pulling strength and drive efficiency . . . plus longer belt life under the toughest war-time operating conditions.

In every way these belts are better—

You'll find they have 50% stronger cords! 20% more cords! A new rubber cushion section that effectively absorbs shock! Full protection against heat, dirt, moisture, and other adverse factors that quickly shorten the lives of ordinary belts.

You'll find, too, they give smooth, silent, slipless, high efficiency performance—in "matched" sets, and in sizes and types to meet your every requirement.

Whatever your war-rushed power transmission needs, don't be satisfied with anything but the best—*and that best is Allis-Chalmers Texrope Super-7—the V-belt for Victory!*

Call your Texrope dealer or the Allis-Chalmers district office near you. Or write Allis-Chalmers, Milwaukee, Wisconsin.

Available in All Sizes
½ hp to 2000 hp

A1473

*Trade mark registered U. S. Patent Office. Texrope Super-7 Belts are the result of the co-operative research and design genius of *two* great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by Allis-Chalmers.

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

Uncle Sam's Hat is in the Ring!

Uncle Sam is putting everything he's got into this great struggle for the freedom of the world. To win it he needs every available ounce of POWER—Power to build and run the machines that make possible the mass conversion of raw materials into finished products—Power to build and operate the equipment essential to the production of oil, gas, gasoline, electricity—Power to move the machines and ships of war.

★

Thus, the Nation's power equipment is the very foundation of Uncle Sam's effort. And so, no matter what part you are playing in this great effort, it is vital to **keep your power equipment operating at maximum efficiency**—for this means not only more power, but also important fuel savings.

★

In determining efficiency, **piston rings are prime factors**—and COOK'S Graphitic Iron Piston Rings have long been favored by builders and operators of industrial prime movers for their superiority in sustaining maximum efficiency with minimum upkeep. Today, COOK'S Rings are being supplied in unprecedented volume to meet the direct needs of Uncle Sam as well as the requirements of engine operators contributing to the war effort.

★

If your engines or compressors are down in efficiency—or if you can use help on any problem pertaining to piston rings—we're ready to serve you. Call or write our nearest office or contact us direct.

★

MORE POWER TO UNCLE SAM

Sealing Pressures

Since 1888

C. LEE COOK MANUFACTURING CO.

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VOGT STEAM GENERATORS

selected for

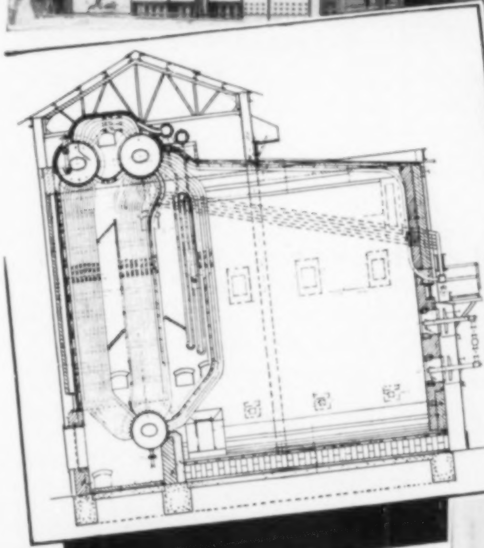
LAKE CHARLES REFINERY, CONTINENTAL OIL COMPANY

Each of the two units comprising this installation is designed to deliver 95,000 pounds of steam per hour with 165 degrees of superheat, using feed water at 212 degrees F.

Steam and water drums are fusion welded and designed for 400 pounds working pressure.

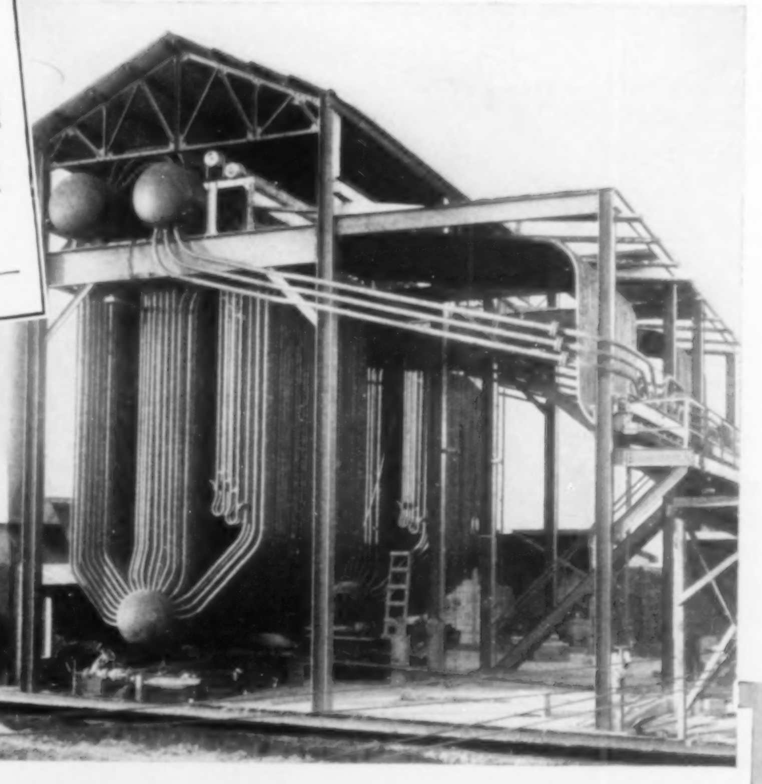
Furnace walls and floors are air cooled and the furnace roofs water cooled. Burners installed in each furnace are arranged to burn Natural Gas or Refinery Gas Fuel.

These units are provided with a roof only and are operated out in the open like oil stills.



Vogt
FOR BETTER BOILERS

Bent Tube and Sectional Header Type Boilers for any fuel!



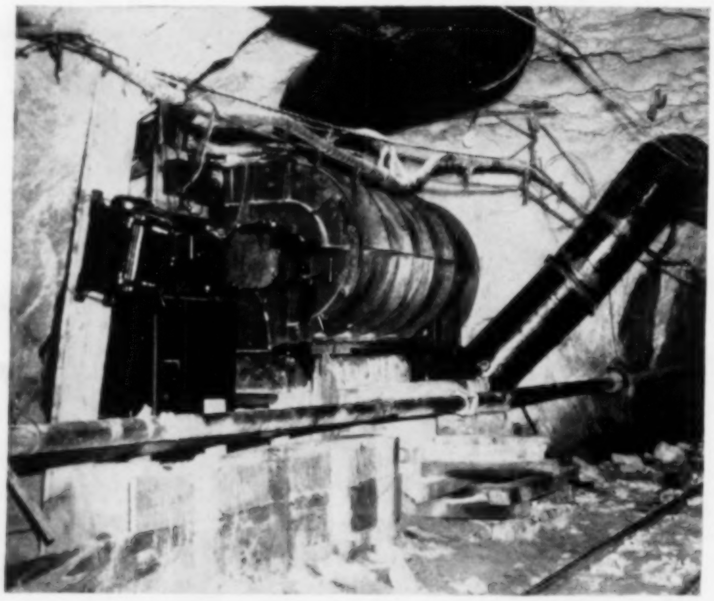
Vogt WATER TUBE BOILERS

HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY.

Branch Offices: *New York • Philadelphia • Cleveland • Chicago • Cincinnati • St. Louis • Dallas*

The Mountain that Breathes

for a Whole Construction Crew



The story of how one of the most successful tunnel-ventilation systems ever devised is helping to conquer the Continental Divide.

By H. R. WALLRATH
Industrial Department
General Electric Company

LIKE a giant respiratory system, deep in the breast of the Continental Divide an electrically powered tunnel-ventilation system is making engineering history. Installation of this system, which is one of the most efficient and effective ever devised, cut 20 minutes from each drilling cycle and added six feet to the daily push in the east portal of the fifty-million dollar tunnel.

When completed, this 13-mile tunnel will bring water from the western to the eastern side of the divide for irrigation of the fertile fields in northern Colorado, and for generation of power essential to war production in that territory.

Before this breathing method was devised, workmen had to wait after each blast for the smoke to clear. Now they return to their posts immediately after firing, without fear of silicosis and suffocation. Not only that, but the ventilator can be regulated to eliminate fog.

The ventilating system consists of heavy-duty reversible-type blowers powered by General Electric 2200-volt, 100-hp motors, connected to the blowers with V-belts. As the work progresses, these blowers are installed 9,000 feet apart along the tunnel. The third blower has just been put in.

The system operates with clockwork efficiency, day in and day out. After the holes have been drilled, the fans are shut off while the powder is being packed for blasting. Immediately after the charge is fired, the operator in the compressor house at the portal of the tunnel—from where the fans are controlled—is notified by telephone.

H. R. WALLRATH

Twenty seconds after the blower at the tunnel portal is started, the next blower starts, and so on down the line. This allows sufficient time for the air to reach each blower and thus prevents the creation of a vacuum, which might damage the duct or blower.

The fans exhaust for 20 minutes, sucking all the powder smoke from the heading. After a one-minute stop to prevent plugging, they are reversed to blow fresh air into the tunnel, and the blowers again start at 20-second intervals.

Fresh air is blown into the tunnel for about 30 minutes, and again the fans are reversed. Exhausting is continued until the heading crew is ready to shoot again. Then the fans are shut off and the whole procedure is repeated.

Blowing and exhausting are timed to conform with the outside temperatures to avoid fog collecting in the tunnel. Thus the heading and tunnel are always free from fog and smoke. This method is more economical than a double blower system—and it added six feet to the day's push.

This is another example of assistance rendered by General Electric engineers to promote electrical and mechanical progress in the construction industry. If you have a problem, their skill, plus G-E equipment, might well bring about the best solution. Just get in touch with our nearest office. We'll be glad to help you. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

655-20-8498

S. S. MAGOFFIN COMPANY

Keeps ahead of schedule

AT THE CONTINENTAL DIVIDE TUNNEL

using I-R Drills, Jackbits & Compressors

(Above) Jackmill and Jackfurnace in the reconditioning shop.

(Below) One of the Ingersoll-Rand Compressors that furnish the air for the job.

INGERSOLL-RAND
IMPERIAL TYPE 10

On December 31st, 1941 the S. S. Magoffin Company had advanced the East Portal of the 9½ foot Continental Divide Tunnel in Colorado more than 22,050 feet. On one record day the tunnel was driven 74 feet — best month's progress 1567 feet.

Efficient organization, hard-hitting DA-35 Power Feed Drifters, fast-drilling time-saving Jackbits, and dependable I-R Compressors are responsible for the record progress on this job.

Four DA-35 Drifters are used on the jumbo. A round comprises from 28 to 38 seven-foot holes. Average drilling time per round is slightly over one hour.

58,000 Jackbits have been used on the job. The Jackmill and Jackfurnace shown are used to recondition the 850 bits that are hotmilled and hardened per shift.

5-122

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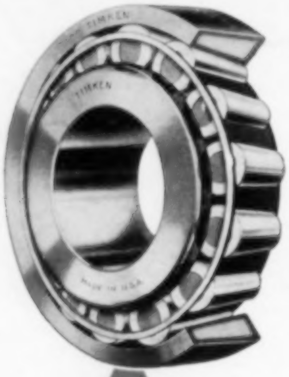
TIMKEN
TAPERED ROLLER BEARINGS



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ALLOY STEELS

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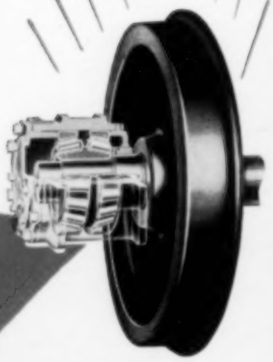
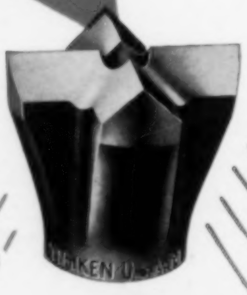
TRADE-MARK REG. U. S. PAT. OFF.

The above trade-mark identifies a group of quality products—each a star in its own right. Make it your buying guide.



TIMKEN
RAILWAY BEARINGS

TIMKEN
SEAMLESS STEEL TUBING



TIMKEN
ROCK BITS

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO